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# **Financial and Real Economy Interactions in South Africa: A Stock and Flow Analysis**

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Thesis submitted for the degree of PhD

2017

School of Financial and Management Studies

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Date:

23.05.2012

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## **Abstract**

This study aims to investigate the impacts on the South African economy of higher government expenditure, capital flow reversal and regulatory changes introducing a higher required leverage ratio for banks. The research framework differs from Dynamic Stochastic General Equilibrium Models as they lack consistent representation of institutional balance sheets and financial sector behaviour.

An alternative model which is micro founded and stock and flow consistent in the tradition of Backus et al. (1980) is constructed and calibrated for South Africa. It provides for a richer representation of institutional balance sheets than existing models. The financial sector's behaviour in this framework draws on the recent theoretical models of Borio and Zhu (2012) and Woodford (2010), which highlight the relationship between bank capital, risk taking behaviour of the financial sector, lending spreads and economic activity. The financial accelerator mechanism operates through the balance sheets of all institutions in the economy.

Solving for the effects of a fiscal shock, the model generates a government expenditure multiplier larger than two in severe recessionary conditions. Although low levels of domestic savings limit the sources of funding to support the fiscal expansion, foreign saving inflows relax the savings constraint, increase liquidity in the market and support the fiscal expansion.

The results from a capital flow reversal shock to the model indicate larger impacts than previous studies. We find that even in the absence of large foreign currency denominated liabilities, a reversal in capital flows can affect the domestic economy through its impact on domestic liquidity, on the risk-taking behaviour of the financial sector and on the demand for assets. The negative effect can be exacerbated if the shock changes the expectation formation process of agents in the economy.

The introduction of a higher leverage ratio for banks is likely to generate negative economic impacts in the short-run that depend on the banks' choice of adjustment

strategy. The negative GDP effect is the greatest if the financial sector reduces leverage through a reduction in the value of its assets (for example, recall of loans) rather than the issue of new equity. The regulatory shock leads to the financial sector changing its perceptions of risk, which reduces the size of the money multiplier and increases lending spreads.

The results indicate the importance of incorporating stock and flow consistent financial sector dynamics in studying macroeconomic shocks. Our results also highlight the importance of the financial sector in transmitting policy interventions and the role of policy in changing the behaviour of the financial sector. Thus, one of our key policy conclusions is that the old model of fiscal and monetary policy coordination is outdated. Effective policy coordination must include macroprudential policy and understanding of the risk behaviour of all institutions in the economy.

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# Chapter 1 Introduction

## 1.1 Motivation

The financial crisis of 2008 questioned our understanding of the role of the financial sector in affecting real economic activity and the effectiveness of monetary and fiscal interventions under conditions of severe economic stress. In response to the crisis, policy makers increased government expenditure; reduced policy rates and increased the balance sheet operations of central banks, thus increasing global liquidity and capital flows; and moved to introduce stricter regulation of the financial sector through the BASEL III reforms.

These developments have led to a significant increase in macroeconomic research aiming to understand: how the real economy and the financial sector interact; under what conditions monetary and fiscal interventions are effective; and the likely impact of higher capital requirements for the financial sector on short and long-term economic activity.

There is consensus that the financial sector is important for economic activity and the cost of financial instability is high. Output losses, measured as deviation from trend GDP, are on average 20 per cent during the first four years (Laeven and Valencia 2008; Laeven and Valencia 2010). Recessions caused by financial crisis tend to be more severe and to be followed by weaker recoveries (Reinhart and Rogoff 2009). The economic literature indicates that the relationship between the real and the financial sectors is driven by the borrower balance sheet channel, the bank balance sheet channel, and the liquidity channel as identified by BCBS (2011). These channels on their own are not able to explain the financial dynamics experienced during the 2008 financial crisis. This has led to the development of theoretical models such as those developed by Borio and Zhu (2012) and Woodford (2010), which provide a major contribution to our understanding of how the financial sector affects the real economy.

In the model developed by Woodford (2010), the lending spread is a function of the financial sector capital. Raising the level of capital is costly and leverage is limited by regulatory requirements. Shocks that impair the capital of the intermediary or higher leverage ratio regulatory requirements translate into higher lending spreads,

lower volumes of lending and economic activity. Borio and Zhu (2012) also link capital of the financial sector to bank behaviour. In their framework, the behaviour is driven by the *capital threshold effect* and the *capital framework effect*. The *capital threshold effect* arises because breaching the minimum threshold is costly for a bank. In the face of a possible breach banks will take defensive action to avoid the high costs, which will affect the availability and pricing of funding extended to customers. The *capital framework effect* influences the way the banks measure, manage and price risk, which affects their behaviour. The economic cycle changes the strength of the capital threshold effect as probabilities of default, valuations and the perception of risk change. In turn, this shifts the relative position of the banks' capital to the regulatory threshold and affects bank behaviour. The accelerator effects in both models are driven by the relationship between capital and economic activity. Higher economic activity reduces the probabilities of default and the perception of risk, and improves valuations. This reduces lending spreads, which encourages further improvements in economic activity. Borio and Zhu (2012) stress that the measurement, management and pricing of risk requires understanding of the distribution of risk across financial instruments and across institutions. This implies that current economic models must have a richer representation of balance sheets if they are to capture the dynamics characterising the financial sector.

In terms of the effectiveness of fiscal policy, the central argument of the mainstream economic research is that under zero lower bound conditions, the fiscal multipliers are significantly larger (Blanchard and Leigh 2014; Christiano, Eichenbaum, and Rebelo 2011; Delong *et al.* 2012; Eggertsson 2009). The underlying mechanism assumes that policy makers do not respond to movements in the output gap and inflation as rates are zero bound, while the increase in inflation expectations reduces real rates. In addition, the higher fiscal multiplier is driven by higher share of credit constrained households (Eggertsson and Krugman 2012). Empirical research also supports the presence of high fiscal multipliers in recessionary conditions (Auerbach and Gorodnichenko 2012; Fazzari, Morley, and Panovska 2015; Owyang, Ramey, and Zubairy 2013; Riera-Crichton, Vegh, and Vuletin 2015).

There is consensus in the economic literature that capital flows are increasingly being driven by global factors and reflect risk-taking behaviour of global financial

institutions (Bruno and Shin 2015; Byrne and Fiess 2016). Financial sector dynamics are key in transmitting capital flow reversal shocks and exacerbating their impact (Joyce and Nabar 2009; Mishkin 1999). The impacts, especially in the case of sudden stops, can be severe: including banking and sovereign crisis with large output and employment losses (Cavallo *et al.* 2015; Eichengreen and Gupta 2016; Magud and Vesperoni 2015; Reinhart and Reinhart 2008).

The introduction of BASEL III aims to improve the stability of the financial sector. The long-term effects on economic activity are expected to be positive (FSB 2010). The short-term effects are likely to be negative, though there is no agreement on the size of the impact. MAG (2010b) finds small negative impacts in the short run with small variations, which are dependent on the tool used to assess the impacts, the response of monetary policy and the spill-over effects across countries. The impacts are largely driven by higher interest rate margins. Slovik and Cournède (2011) and EU (2011) find similar results. However, IIF (2011) finds significantly larger effects. The impact depends on how the higher capital ratios are achieved. Achieving the higher ratio through reducing dividends is likely to have a smaller impact on the credit cycle compared to reducing the loan portfolio (Cohen and Scatigna 2016; Zhu 2008). Empirical research indicates that banks globally have chosen to increase their retained earnings as an instrument to achieve the higher capital requirements (Cohen and Scatigna 2016).

While there is broad recognition of the importance of financial sector dynamics, the studies lack consistent representation of institutional balance sheets and the dynamics identified by Borio and Zhu (2012) and Woodford (2010) .

Modern Dynamic Stochastic General Equilibrium (DSGE) models rely on the financial accelerator mechanism identified by Bernanke, Gertler, and Gilchrist (1999) or a household collateral constraint mechanism following the approach by Iacoviello (2005). These models assume rational expectations and dynamics based on a representative agent, implying almost perfect foresight of risk, which hinders the incorporation of cross-sectional and inter-temporal coordination failures (Borio and Zhu 2012). In addition, the financial accelerator mechanism ignores the time-varying pricing of risk and effective risk tolerance. It is only the balance sheet of a representative firm that is important in the financial accelerator mechanism. The

models ignore how other balance sheets are affected and how all balance sheets interact to determine the impact on the economy. Duca and Muellbauer (2014) provide additional criticisms. They argue that in the model by Bernanke, Gertler, and Gilchrist (1999) the financial frictions are based on only one-period dynamics and the mechanism relies only on costly monitoring carried out by banks. There is no role for housing or housing markets and there is no feedback via the asset base, and the potential solvency of the financial sector is missing. Iacoviello (2005) does not include banking sector dynamics.

Our analysis aims to build on the current literature and present a framework which has more detailed financial sector behaviour. The frameworks developed by Borio and Zhu (2012) and Woodford (2010) are key to our analysis. This allows for better understanding of the transmission mechanism of economic and financial shocks and more informed policy making. Our analysis focuses on South Africa, an emerging market economy with a highly developed financial sector and high reliance on capital inflows.

## 1.2 Objective

The objective of this thesis is to answer three questions in the context of the South African economy. These are:

1. Was fiscal policy effective in the period immediately after the 2008 financial crisis?
2. What is the likely impact of capital flow reversal on the economy?
3. How would the introduction of a higher leverage ratio affect the economy?

To answer the three questions and address the limitations of current studies, we develop a stock and flow consistent model in the tradition of Backus *et al.* (1980). Our model uses flow-of-funds data produced by the South African Reserve Bank to build balance sheets for institutions and create a series of financial Social Accounting Matrices.

For the first question, we study the impact of higher government consumption expenditure under recessionary conditions, functioning financial sector and low government debt. These were the conditions in South Africa in the period immediately after the 2008 financial crisis. We compliment the government

expenditure shock with a capital flows shock. This aims to capture the prevailing conditions in South Africa. Higher global liquidity translated to a sizable increase in capital inflows.

Capital flows can drive the creation of an asset bubble. This is particularly the case for currencies such as the South African rand, which are subject to carry trade dynamics (Hassan 2015). The bursting of a bubble represents a threshold point or discontinuity driven by the sudden stop in capital flows. This can lead to a sudden change in economic behaviour: for example, a change in the way households form expectations. In addressing the second question, we highlight how capital flow reversal may affect the economy through the financial sector and how this effect can be exacerbated if households change their expectation formation process.

The shock to the leverage ratio is accompanied by different options to raise the ratio. These include reducing the size of assets, increasing retained earnings and raising equity capital. In answering the question, we illustrate the ability of our framework to capture how the management and pricing of risk by the financial sector drives the economic outcomes.

### 1.3 Contribution

The contribution of this work is in three main areas. Our first contribution is a technical one, which illustrates how the financial sector can be better represented in macroeconomic models. It also highlights the importance of the current G20 Data Gap Initiative, which will lead to significant improvements in the quality and availability of financial data and allow for further development of the framework, presented in the thesis.<sup>1</sup> We develop a stock-and-flow-consistent model with optimising firms and households and a financial sector that manages its reserves in response to perceptions of risk. Our approach to modelling household expectations is different from current DSGE models. We aim to capture bounded rationality, which is supported by recent research on expectations (Hommes 2011; Roos and

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<sup>1</sup> For more information of the G20 Data Gap Initiative see <http://www.fsb.org/2016/09/second-phase-of-the-g20-data-gaps-initiative-dgi-2-first-progress-report/>

Luhan 2013).<sup>2</sup> More importantly, our framework captures elements of the theoretical models developed by Borio and Zhu (2012) and Woodford (2010).

The second set of contributions is in terms of understanding how fiscal, capital flow and leverage shocks are transmitted. Our results reaffirm that fiscal multipliers are large under recessionary conditions, rising global liquidity, functioning financial sector and government debt levels, which are perceived as sustainable. Unlike studies which employ DSGE models, the size of the multiplier is highly dependent on how the financial sector perceives risk and changes its reserve management policy. This affects lending and liquidity in the market, which in turn affects lending spreads and asset prices. Economic activity and the balance sheets of other institutions in the economy are affected, which feeds back into the financial sector and creates a financial accelerator mechanism. Our ability to model these effects is driven by the stock-and-flow consistency of our framework.

In Chapter 4, we present the capital flow reversal shocks. Capital outflows reduce the demand for financial assets and affect negatively the money creation process and asset prices. A key contribution in this chapter is the link that we establish between sudden stops and the literature on catastrophe theory (Thom 1976).<sup>3</sup> Harris (1979) shows how a simple economic behavioural function can be related to catastrophe theory. He illustrates how shifts in expectations can be explained by catastrophe theory dynamics. While the control variables (for example, national income) remain continuous, expectations (of growth of income) can suddenly change as the control variable reaches a threshold point (full capacity utilisation).

We argue that capital flow movements can cause the creation of asset bubbles, which occasionally burst as sudden stops occur. The presence of these discontinuous points is not assumed in current mainstream models and yet they can contribute to large negative impacts. A second contribution to understanding the transmission of capital flow reversal shocks is that even in the absence of large foreign-denominated liabilities, a capital flow shock can have a sizable impact on

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<sup>2</sup> Bounded rationality originates in the work of Herbert Simon. For more information see Simon (1955), Simon (1982) and Simon (1986)

<sup>3</sup> Rosser Jr (2007) provides a comprehensive review of the literature on catastrophe theory and counterarguments to the criticisms raised. He also provides a review of other models that aim to capture dynamic discontinuities. Most of these models are similar to catastrophe theory and generate similar equilibrium surfaces.



the economy through its impact on liquidity and demand for domestic financial assets.

Our analysis contributes to the current work on understanding the short-term impacts of BASEL III. The leverage ratio shock confirms that outcomes depend on how the capital ratio is achieved. The results generated are larger than those generated by other studies on South Africa. They highlight the importance of the risk-taking behaviour of the financial sector and its interactions with other institutions in the economy. The analysis contributes to a better understanding of the transmission mechanism and the implications for monetary policy.

Our third and final contribution is that the research adds to the knowledge base in South Africa. To the best of our knowledge, this is the first framework of this type that has been used to study questions on fiscal multipliers, capital flows and leverage ratios. Our results also highlight the importance of the financial sector in transmitting policy interventions and the role of policy in changing the behaviour of the financial sector. Thus, one of our key policy conclusions is that the old model of fiscal and monetary policy coordination is outdated. Effective policy coordination must include macroprudential policy and understanding of the risk behaviour of all institutions in the economy.

## 1.4 Structure of the thesis

**Chapter 1** is the introductory chapter. It provides motivation for the research, and it outlines the objectives and the main contributions.

**Chapter 2** provides a short overview of the South African economy. The chapter highlights the fiscal response post the 2008 financial crisis, the country's experiences with capital flows and its progress with the introduction of the BASEL III reforms.

**Chapter 3** presents the modelling framework. The model framework is compared to current DSGE models and Post-Keynesian stock-and-flow models. Our framework is stock-and-flow consistent in the tradition of Backus *et al.* (1980) with several characteristics resembling current mainstream DSGE models. The data used in the analysis is described and a detailed description of the model is presented.

**Chapter 4** investigates the impact of capital flow reversal shocks. South Africa does not have sizable foreign-currency-denominated debt and thus foreign-currency mismatches are not expected to drive the impacts. The model generates larger impacts than previous studies on capital-flow reversal shocks in South Africa. The impact on the demand for domestic assets and the possible change in expectations are found to be important channels in the transmission of capital-flow reversal shocks. These effects tend to offset any positive effects associated with the depreciation of the currency.

**Chapter 5** presents the fiscal shocks. Government consumption growth is increased by one percentage point. We investigate whether the combination of higher fiscal expenditure and higher capital inflows had a strong positive impact on economic activity in the period immediately after the 2008 financial crisis. We also investigate the sensitivity of the results to the size of the output gap. Our conclusion is that the presence of financial dynamics can significantly increase the size of the fiscal multipliers. The impact is a function of the risk-taking behaviour of the financial sector and the consequent impact on lending spreads and asset prices. Expectations that the output gap may be closed faster can reduce the impact, as households expect an increase in the policy rate.

**Chapter 6** looks at the likely impact of higher leverage ratios on the South African economy. We highlight the importance of the capital framework effect and capital threshold effect as defined by Borio and Zhu (2012). Our results confirm that achieving the ratios through higher retained earnings is the least costly option; however, we also highlight that this is likely to reduce household consumption in the short run. We conclude by reemphasising that the effectiveness of monetary policy depends on policy makers understanding the impact of macroprudential interventions on risk-taking by the financial sector, the impact on lending spreads and extension of loans and the feedback effects through the real and financial behaviour of other institutions.

**Chapter 7** summarises our results, provides the implications for macroeconomic policy based on our analysis and highlights the limitations of the research.

## Chapter 2 Overview of the South African Economy

### 2.1 Overview

The aim of this chapter is to provide a short overview of the South African economy, highlighting its economic developments and characteristics, which are key to our analysis.

South Africa's key macroeconomic policy characteristics include inflation targeting and a flexible exchange-rate regime, which were introduced in 2000, and a sustainable counter-cyclical fiscal policy. These policy interventions have been fundamental in achieving macro stability and responding effectively to domestic and global shocks.

The introduction of a market-determined inflation exchange rate has increased exchange rate volatility, but it has also reduced the accumulation of foreign-currency-denominated debt (Hassan 2015). South Africa's total foreign debt stood at 43.6 per cent of GDP in the first quarter of 2016, and just over half of it was denominated in foreign currency. This reduces the probability of large and disruptive sudden-stop episodes and supports the effectiveness of the macroeconomic framework. The composition of South Africa's foreign debt informs our approach to modelling the country's foreign liabilities in our stock and flow consistent framework.

Another defining feature of the South African economy is its well-developed financial sector. The 2016 Global Competitiveness Report ranks South Africa twelfth in terms of its level of financial sector development.<sup>4</sup> The South African rand is the 20<sup>th</sup> most traded currency globally and the country has one of the highest market capitalisation to GDP ratios (Figure 2.1).<sup>5</sup> The Johannesburg Stock Exchange is ranked 18<sup>th</sup> globally in terms of its market capitalisation.<sup>6</sup> South Africa's deep and liquid financial markets facilitate funding for private and public institutions and support economic development. This indicates that analysis of

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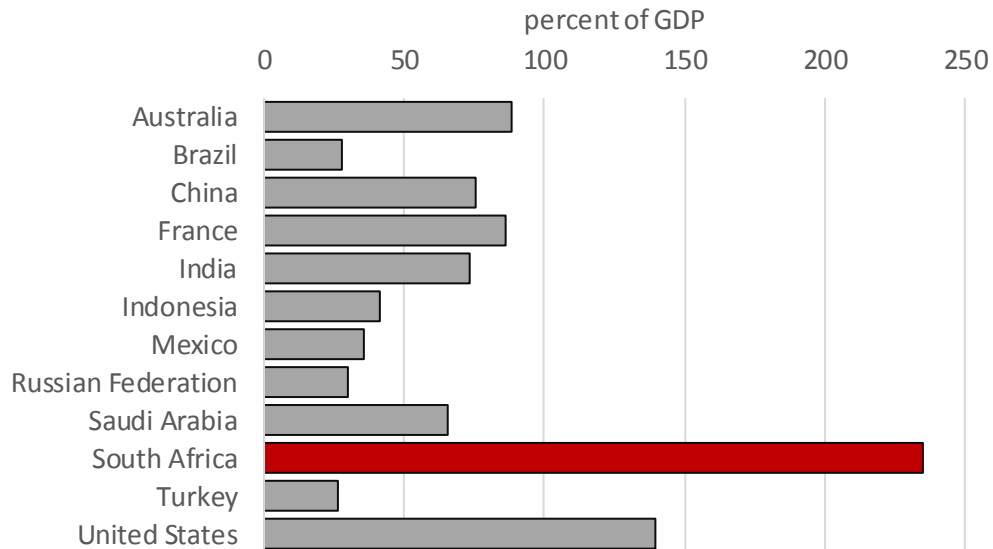
<sup>4</sup> The report is available at <http://reports.weforum.org/global-competitiveness-report-2015-2016/competitiveness-rankings/>

<sup>5</sup> See the Bank for International Settlements Triennial Central Bank Survey available at <http://www.bis.org/publ/rpfx16fx.pdf>

<sup>6</sup> As of October 2016

macroeconomic shocks in the South African context needs to consider financial sector behaviour.

**Figure 2.1: Market capitalisation to GDP (%-selected G20 economies)**



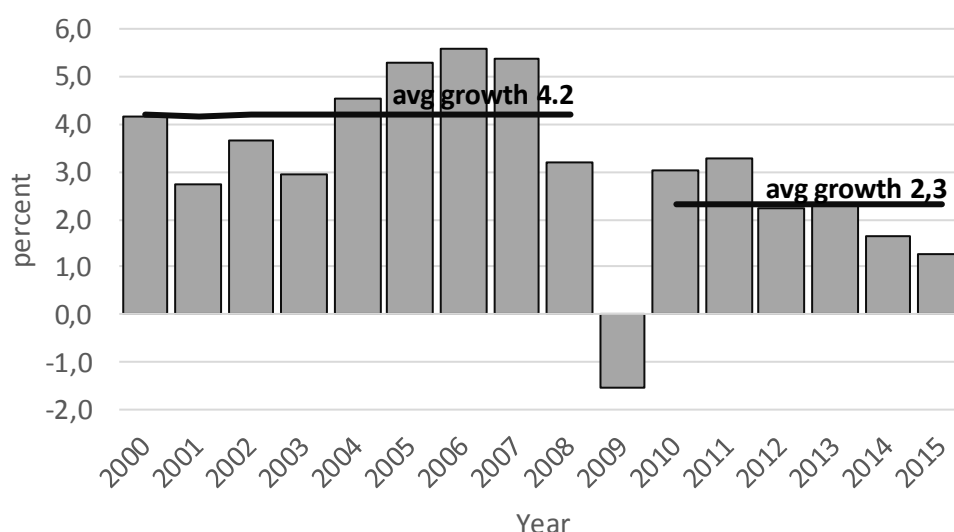
Source: The World Bank

We proceed with a brief overview of South Africa's economic performance. Over the period 2000 to 2008, South Africa recorded strong growth rates, like other emerging markets, particularly those that rely heavily on commodity exports. Overall inflation levels were lower compared to the decade before, supported by the inflation targeting regime. While employment growth was equally robust, the unemployment rate remained above 20 per cent. Higher employment growth was matched by higher participation rates. The major drivers of growth were household consumption and expansion in the tertiary sector. Protracted uncertainty related to mining legislation did not allow the mining sector to take advantage of the commodity boom, which distinguished South Africa from other commodity-based economies.

The high levels of economic activity also exposed South Africa's low levels of domestic savings. Economic growth rates of above 5 per cent were accompanied by current account deficits of close to 7 per cent. Corporates accounted for most of the domestic savings, while household savings rates often were and remain negative. The reliance on capital inflows has become a major source of vulnerability and of policy concern.

South Africa's structural constraints are well documented. These include infrastructure bottlenecks, low levels of competition in certain markets, skill shortages, volatile labour relations and inflexible labour markets, regulatory constraints and inefficient state-owned enterprises (Faulkner, Loewald, and Makrelov 2013; NPC 2013; NT 2016)

**Figure 2.2: Expenditure on GDP (y-o-y % change)**



Source: Statistics South Africa

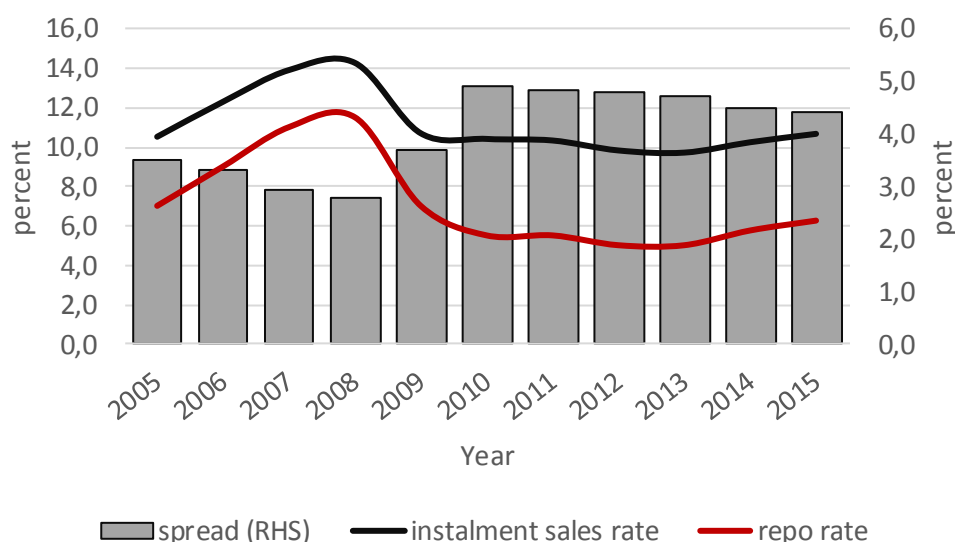
Over the period 2010 to 2012, the recovery in the economy achieved growth rates in the region of 2.3 to 3.3 per cent. South Africa did not experience a financial crisis. However, as shown in Figure 2.2, trend growth slowed significantly. In addition to the factors outlined above, the following specific factors shaped the economic landscape post the 2008 financial crisis:

1. Sustained fiscal spending by the South African government.
2. Protracted and violent labour strikes in the mining and manufacturing sectors.
3. Electricity shortages.
4. Increased levels of policy uncertainty driven by badly designed and coordinated policies as well as political instability.
5. Slow global recovery and a decline in commodity prices.
6. Unconventional monetary policy in advanced economies and significant capital flows into emerging markets.
7. The introduction of stricter regulatory requirements for the financial sector.

The economic slowdown was accompanied by a significant decline in the policy rate. The average repo rate declined from 11.6 per cent in 2008 to 5 per cent in

2013. The impact on lending rates, however, decreased by less as the lending spread widened. In Figure 2.3, we plot the instalment sales rate against the repo rate. The spread has widened from 2.7 per cent in 2008 to 4.7 per cent in 2013.<sup>7</sup>

**Figure 2.3: Lending spread**



Source: South Africa Reserve Bank

The increase in the spread coincides with a slower pace of lending growth and economic activity, higher risk aversion post the 2008 crisis, and the imminent implementation of new capital requirements under BASEL III. This indicates that the mechanism identified by Woodford (2010) and Borio and Zhu (2012) may be present in the South African economy and, thus, it is relevant to include it in our analysis.

In the rest of the chapter, we provide a brief overview of the fiscal conditions pre- and post the financial crisis, capital flow movements and South Africa's financial sector regulatory framework.

## 2.2 The Fiscal Environment

South Africa's fiscal system is based on three spheres of government: national, provincial and local. The Constitution provides guidelines for the types of

<sup>7</sup> We use the instalment sales rates to measure lending costs rather the prime lending rate. The prime lending rate has a fixed margin of 3.5 per cent to the repo rate. Banks price debt relative to the prime lending by imposing either a positive or negative mark-up. This is captured in the instalment sales rate, which measures mainly the rate applied to purchases of vehicles.

expenditure for which each sphere of government is responsible. For example, national government is responsible for expenditure having a national dimension such as defence, tertiary education and foreign affairs. Provincial and national governments share responsibilities in areas such as education and health, while local government is responsible for expenditure on areas of municipal significance such as water and electricity reticulation, cemeteries and local sports facilities. The division of revenue is entrenched in law and is guided by the Division of Revenue Bill, which ensures fair distribution of resources across the different spheres of government. Tax policy falls under the domain of national government. Provincial governments have limited revenue-generating power and are only allowed to borrow under very limited circumstances, while local governments have some significant revenue-generating instruments such as property rates and service charges, and they can also borrow.<sup>8</sup> While the political system is quasi-federal, the fiscal system is more centralised with the revenue powers lying largely with the national government. The national government also has important oversight responsibilities over all spheres of government, including state-owned companies through the Public Finance Management Act and Municipal Finance Management Act. The institutional framework ensues that national government, and particularly the National Treasury, is responsible for fiscal policy.

South Africa's fiscal position was strong at the beginning of the financial crisis. Gross and net debt levels were between 20 and 30 per cent. As economic activity contracted, the output gap widened. Klein (2011) reports an output gap of negative 2.4 per cent and negative 1.4 per cent for 2009 and 2010, respectively. Ehlers, Mboji, and Smal (2013) calculate similar sized output gaps, while Anvari, Ehlers, and Rudi (2014) estimate slightly more negative output gaps. These estimates internalise the scaling up of fiscal expenditure. The combination of low government debt, underutilisation of economic resources and a well-functioning financial sector<sup>9</sup> created the conditions for countercyclical increase in government expenditure. Real government consumption expenditure increased by 5.8 and 4.6

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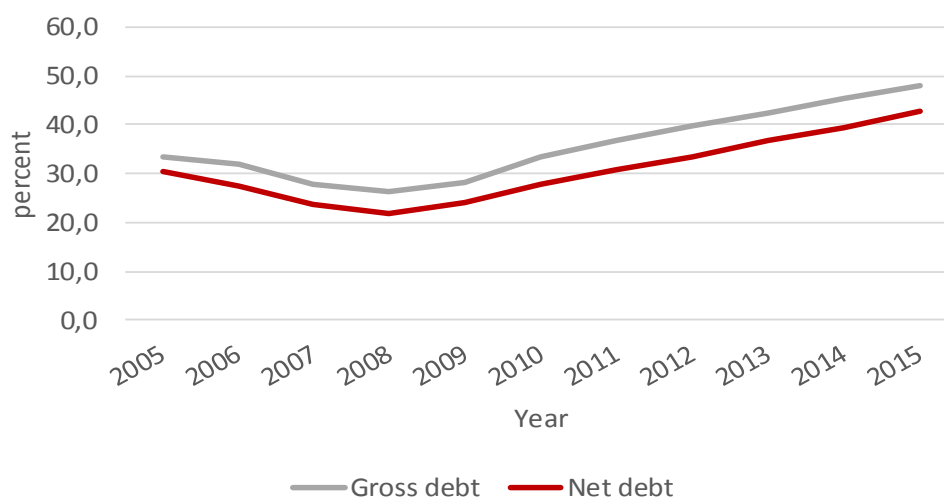
<sup>8</sup> Only large metros can borrow, with permission from National Treasury. Some of the small municipalities are completely dependent on grants from national government.

<sup>9</sup> South Africa's banks remained profitable during the crisis with high asset quality and capital ratios. While the share of nonperforming loans within total loans jumped from 2 to 6 per cent, it has been declining continuously since 2010 (IMF 2015).

per cent in 2008 and 2009, well above the average economy-wide growth rate. Consumption expenditure remained close to or just above average growth in economic activity in 2010 and 2011.

However, as the economy was hit by several supply side shocks, the sustainability and effectiveness of the fiscal expansion became questionable. Over the period 2012 to 2016, potential growth estimates were revised down, with the most recent estimates in the region of 1.9 to 2.4 per cent (Fedderke and Mengisteab 2016). Government debt levels, as a percentage of GDP, started to approach the 50 per cent level (Figure 2.4). The economic literature indicates that at high debt levels, the fiscal multiplier becomes negative as the borrowing cost effect dominates the aggregate demand impact of higher fiscal expenditure (Caner, Grennes, and Koehler-Geib 2010; Elmeskov and Sutherland 2012; Reinhart and Rogoff 2010). This channel requires the modelling of government debt balances and provides further support for the incorporation of stock-and-flow-consistent dynamics in our analysis. Concerns regarding the sustainability of government debt due to the threat of sovereign rating downgrade led to the implementation of spending ceilings, which were revised down in 2015 and 2016.

**Figure 2.4: Government debt (% of GDP)**



Source: South African Reserve Bank

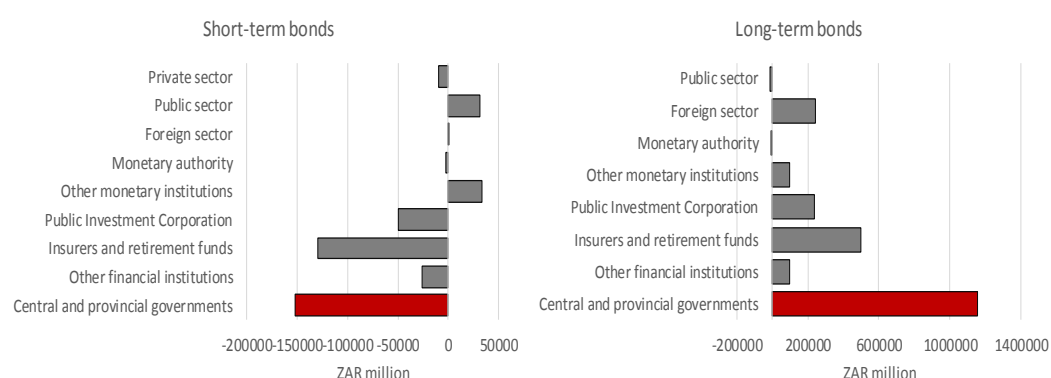
While government increased its overall levels of government debt significantly, it managed to change the composition of debt. Using the flow-of-funds data produced by the South African Reserve Bank we plot the cumulative change in



short- and long-term debt over the period 2008 to 2015 in Figure 2.5: Cumulative government debt issuance over the period 2008 to 2015

The red bar represents the issuance, while the grey bars show the institutions that have purchased the government debt and the amounts. Most of the long-term government debt issued has been purchased by *Insurers and retirement funds*, the *Public Investment Corporation* and the *Foreign Sector*.

**Figure 2.5: Cumulative government debt issuance over the period 2008 to 2015**



Source: South African Reserve Bank

The bonds purchased by *the foreign sector* are largely rand denominated. Only about 10 per cent of the government debt is foreign currency denominated. The purchases of bonds by *Insurers and retirement funds* and the *Public Investment Corporation* reflect another important institutional characteristic of the South African system, which is the pension system. The *Public Investment Corporation* manages the funds of the Government Employees Pension Fund. Individuals accumulate savings for retirement and then use them to purchase retirement annuities once they retire. The fund managers use the retirement savings to purchase various financial instruments and generate growth for their members. They can invest up to 25 per cent of their portfolio in overseas markets. There is a relationship between household consumption (savings of households) and demand for government bonds, return on government bonds, and also demand for foreign assets and other domestic financial instruments. This relationship is one example of how the real and financial sectors interact and the importance of including financial dynamics in the analysis of fiscal multipliers in South Africa.

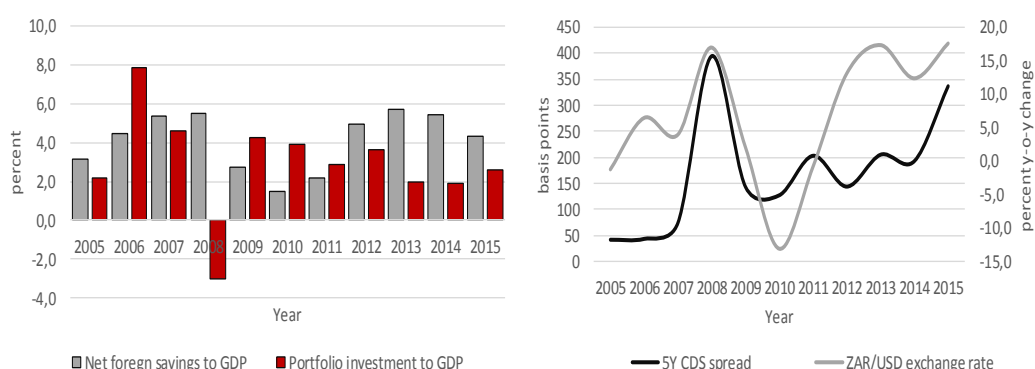
Figure 2.5 also indicates that in the South African context, the monetary authority does not conduct balance sheet operations by purchasing government bonds. They mainly use forex swaps in open market operations.

## 2.3 Capital Flows

The structurally low levels of domestic savings have led to high reliance on foreign savings. This has increased South Africa's vulnerability to capital-flows volatility.

Figure 2.6 shows the general trend in capital flows as represented by the net foreign savings to GDP and portfolio investment to GDP ratios. The strong increase in CDS spreads in 2008 has very negatively affected portfolio flows but not overall capital flows. Net foreign direct investment and net other investment has provided a buffer. Portfolio flows tend to be more sensitive to risk perceptions. Also, some of the effects have been offset by the rand's depreciation. The rand-dollar exchange rate depreciated by 17 per cent in 2008. The data shows a notable decline in foreign savings inflows over the period 2009 to 2011 and then a rise, in line with the unconventional monetary policy interventions by several advanced economies and the increased levels of global liquidity. Portfolio investments generally show higher levels of volatility.

**Figure 2.6: Capital flows, CDS spreads and the exchange rate**



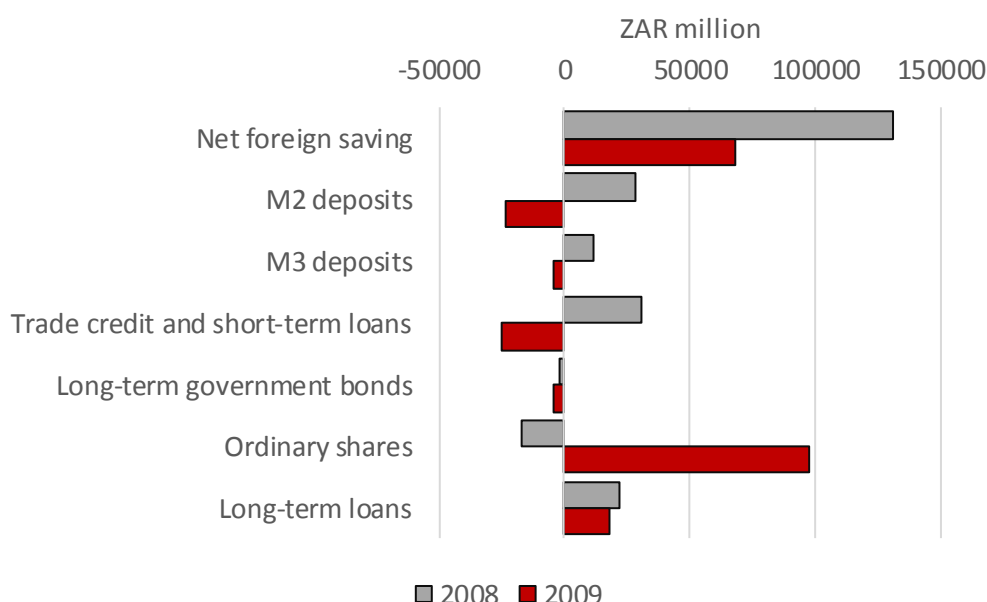
Source: South African Reserve Bank

The flow of funds data indicates that most of the cumulative foreign savings inflows over the period 2008 to 2015 have gone on net basis into *Trade credit and short-term loans, long-term loans, government bonds, and M2 and M3 deposits*. This indicates that the foreign sector plays an important role in the money creation process, the provision of loans and the demand for assets. Despite these large

foreign savings inflows, the foreign-currency-denominated liabilities are relatively small at just over 20 per cent of GDP. This an important feature of the South African economy, which reduces its vulnerability to capital flow reversal shocks.

In Figure 2.7, we show the adjustment to the large fall in net foreign savings from 2008 to 2009 in terms of the accumulation of net financial assets by the foreign sector. We present the asset classes that have seen the largest adjustment. These include deposits with the financial sector and some of the loan categories. There was a significant increase in the holding of equities. This adjustment reflects an overall decline in net foreign savings compared to 2008 and changes to expected relative returns. The average repo rate in 2008 was 11.6 per cent, compared to 8.4 per cent in 2009, while the JSE All Share index declined by 13 per cent in 2009. The combination of lower equity prices, a weaker rand and good dividend payouts may have created expectations of higher future returns amongst foreign investors, especially given the carry trade characteristics of the South African rand.

**Figure 2.7: Adjustment to lower net foreign savings**



Source: South African Reserve Bank

The outcomes also indicate that the impact on capital flow reversal is operating through the financial sector and asset prices. The foreign sector affects bond and equity markets as well as the money multiplier though its impact on loan extension

and direct deposits into the financial system. Assessing the impact of capital flows on the economy requires an understanding of how they affect asset prices, interest rates and the various markets for financial instruments.

## 2.4 Capital Requirements

The South African Reserve Bank (SARB) is responsible for the regulation and supervision of banks and mutual banks. Its mandate, outlined by the Banks Act and the Mutual Banks Act, is exercised through the Registrar of Banks and the Bank Supervision Department. The Minister of Finance is responsible for issuing regulations and formally making supervisory actions. The Financial Services Board (FSB) regulates and supervises the non-bank financial services industries, including insurance companies. Fund managers and stock exchanges are jointly supervised by the FSB and the Johannesburg Stock Exchange. The National Credit Regulator, which reports to the Minister of Trade and Industry, has certain regulatory powers over lending activity for consumer protection.<sup>10</sup>

South Africa is currently in the process of implementing BASEL III, which started in 2013. The regulatory model will follow the Twin Peaks approach by setting up a Prudential Authority and a Financial Sector Conduct Authority, both to be housed at the Reserve Bank. In terms of progress, the International Monetary Fund and the Basel Committee for Bank Supervision find that South Africa is compliant with the recommendations for Effective Banking Supervision (BCPs) and the adoption of key BASEL III ratios. The phasing-in of the regulation is expected to be completed by 2019. The regulatory framework, which is assessed to be in line with best practices, highlights again the high level of financial sector development in South Africa.

In some cases South Africa's regulatory regime tends to be stricter than BASEL III in terms of speed of implementation and size of the ratios. The BASEL III recommends that the risk-weighted capital adequacy ratio should be 8 per cent, while the South African authorities are implementing a higher ratio of 10.5 per cent.

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<sup>10</sup> IMF (2015), BCBS (2015a) and BCBS (2015b) provide a comprehensive review of the regulatory framework and the progress made with the implementation of BASEL III.

South Africa will phase in the leverage ratio by 2018 in line with the recommendations by the Basel Committee on Banking Supervision.<sup>11</sup> Its introduction aims to restrict the build-up of leverage and reinforce the risk-based requirements. The current level set by BASEL III is 3 per cent. The ratio maybe adjusted further, based on the current evaluation period whereby regulatory authorities are tracking the behaviour of the leverage ratio relative to the risk-based capital requirements.

**Table 2.1: Selected Financial Soundness Indicators (sample of G20 economies)**

Year 2015 (end of period)	Regulatory Capital to Risk-Weighted Assets	Regulatory Tier 1 Capital to Risk- Weighted Assets	Capital to Assets (leverage ratio)	Return on Equity
Australia	13,9	11,9	6,3	18,6
Brazil	16,4	12,7	8,5	15,4
China	13,5	11,3	8,4	15,0
France	17,1	13,8	5,8	6,8
India	12,7	10,1	7,2	6,3
Indonesia	21,3	18,8	13,6	17,3
Italy	14,8	12,3	6,2	3,4
Mexico	15,0	13,3	10,4	15,4
Russian Federation	12,7	8,5	8,9	2,0
Saudi Arabia	18,1	16,2	13,9	14,5
<b>South Africa</b>	<b>14,2</b>	<b>13,8</b>	<b>7,0</b>	<b>20,6</b>
Turkey	15,6	13,2	11,0	13,6
United Kingdom	19,6	15,7	6,8	13,6
United States	14,1	13,1	11,7	3,0

Source: International Monetary Fund

South Africa's capital ratios compare favourably against the benchmarks set by the Basel Committee on Bank Supervision as well as the current ratios of other countries. The risk-weighted measures are higher than in the other BRICS economies and higher than some advanced economies such as Australia and the United Kingdom (Table 2.1). It stands out that South Africa has the highest equity

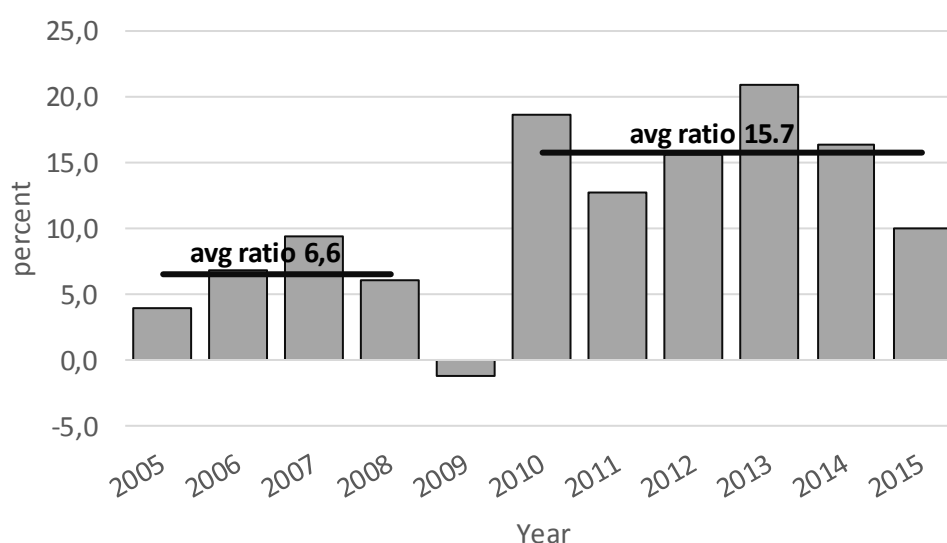
<sup>11</sup> BCBS (2014) provides the framework for calculation and introduction of the leverage ratio.

return amongst the sample of countries, highlighting the strong profitability of the sector.

Despite the relatively high capital ratios, South African banks have chosen to raise them over the period 2008 to 2016. The regulatory capital to risk-weighted assets ratio has increased from 13 per cent in 2008 to 15.2 per cent in 2016. Over the same period, the tier 1 ratio has increased from 11.2 to 14 per cent and the leverage ratio from 5.7 to 7.8.

Using the flow of funds data and plotting the ratio of net savings of the financial sector to the net incurrence of financial assets, it appears that the adjustment to higher capital ratios has taken place mainly through higher retained earnings (Figure 2.8). Cohen and Scatigna (2016) also provide empirical evidence that banks in emerging markets, including South Africa, have used retained earnings to achieve higher capital ratios.

**Figure 2.8: Ratio of net savings of the financial sector to the net incurrence of financial assets**



Source: South African Reserve Bank

## 2.5 Conclusion

In this chapter, we have explained briefly the macroeconomic environment post the 2008 financial crisis. Our emphasis has been on three distinct macroeconomic factors: fiscal policy developments, capital flow movements and the introduction of new financial sector regulatory requirements. These three areas form the core of

macroeconomic issues faced by the South African economy as well as other emerging economies with high reliance on foreign savings.

The data highlights the interaction between these three areas and the financial sector. In addition, it indicates the possible presence of the mechanisms identified by Borio and Zhu (2012) and Woodford (2010). This emphasises the importance of including financial sector dynamics in the study of fiscal multipliers, capital flow reversal shocks and the introduction of higher capital requirements.

## Chapter 3 Model Description

### 3.1 Our Framework and How it Relates to Other Models

In this chapter, we provide a detailed description of our framework and we compare it to other economic models. Over the last 60 years, two fundamentally different paradigms for explaining macroeconomic behaviour have emerged. The first, the neo-classical approach, argues that economic activity is driven by the aspirations of individual economic agents, who are rational. If all markets clear, there is no involuntary unemployment and national income is distributed optimally between wages and profits. Production is instantaneous with the market-clearing mechanism ensuring that demand and supply are brought into balance. Loans, credit, money, and inventories are not needed to bring product markets into equilibrium. The profit-maximizing level of output is determined by the marginal product of labour and the real wage. The demand for and supply of labour are a function of the real wage. The demand for real money balances is determined by income and the rate of interest. The supply of money is exogenous. Market clearing takes place through adjustment in the various prices. Long-term equilibrium is determined by real variables and the government and the Central Bank have a limited role in achieving this equilibrium (Godley and Lavoie 2012). The mainstream paradigm has introduced some rigidities in prices and wages and monopolistic competition, which have become a defining feature of the current New Keynesian approach.

The alternative paradigm, called post-Keynesian or structuralist approach, sees economic agents as being adaptively rational. There is no natural tendency for economies to generate full employment and hence government through fiscal, monetary and income policies has an important role to play. Loans, credit, money and inventories are important in smoothing consumption and production. This approach is characterised by imperfect competition, imperfect information, mark-up pricing, fixed technical coefficients, and long-run trends being described as a function of a chain of short-period decisions (Godley and Lavoie 2012).

Our framework has elements of both, the New Keynesian approach and the structuralist approach. We review the properties of the two frameworks and then we compare them against our model.



### 3.1.1 Dynamic Stochastic General Equilibrium (DSGE) models

Dynamic Stochastic General Equilibrium (DSGE) models are the most advanced tool of the neoclassical approach and are playing an increasingly greater role in the formulation and communication of monetary policy. Their origin lies in the work of Lucas Jr (1975), Kydland and Prescott (1982) and Long Jr and Plosser (1983) on real business cycles. Central Banks are the main users of current DSGE models. Sbordone *et al.* (2010) present their key features:

- *Micro foundations based on production and utility functions.* Consumers and firms maximize welfare and profits subject to budget constraints. The micro foundations aim to address the Lucas critique of forecasting models.
- *Estimation techniques based on Bayesian statistics.* This allows for prior information to be incorporated in the estimation process. DSGE models are estimated as a system rather than equation by equation as the previous generation macro econometric models.
- *Monetary policy reaction function often in the form of a Taylor rule.* This highlights their primary role, which is monetary policy analysis.
- *Price and wage stickiness.* This implies that prices and wages do not adjust instantaneously to economic disturbances. Markets always clear through adjustment in the quantities supplied and demanded, and therefore there is always short-term equilibrium.
- *Dynamic interaction between the various model blocks, guided by rational expectations.* DSGE models are solved over a period of time. They are generally suited for short-term analysis. Dotsey (2013) and Wickens (2011) argue that the rational expectation assumption simply indicates that agents do not make systematic errors.
- *Stochastic in nature.* This aims to bring the element of uncertainty in the model framework. This means that they incorporate random components that explain the cyclical behaviour of the economy.
- *Intertemporal optimisation.* Current decisions are based on forecasts about the future.

There are two milestone articles that have added more properties to DSGE models, while at the same time making them more suited for policy analysis. Christiano, Eichenbaum, and Evans (2005) introduced

- habit formation in preferences for consumers;
- adjustment costs in investment;
- variable capital utilisation; and
- the need for firms to borrow working capital in order to finance their wage bill.

They also showed that an optimisation-based model with nominal and real rigidities can account successfully for the effects of a monetary policy shock.

The second milestone article was the seminal technical contribution of Smets and Wouters (2003). They were the first to estimate a micro-founded DSGE model using Bayesian estimation and use it to forecast. The model consists of seven variables (GDP, consumption, investment, prices, real wages, employment and the nominal interest rate) and ten structural shocks (including productivity, labour supply, investment preferences, cost-push and monetary policy shocks).

Recently, DSGE models have tried to improve their specification of financial sector dynamics. Wickens (2011) presents a DSGE model that can cater for bank defaults. Households can take loans and buy bonds. Banks have a utility function, which determines their nominal loans and nominal borrowing. Loan rates are generally higher than deposit rates, reflecting the probability of default. A sudden shock to the loan rate may lead to default as the net present value of an investment project turns negative. The ability of the representative bank to borrow from other financial institutions is limited by its balance sheet (Ellison and Tischbirek 2014; Gertler and Karadi 2011; Gertler, Kiyotaki, and Queralto 2012). Many of the models capture financial dynamics using either the financial accelerator mechanism as defined by Bernanke, Gertler, and Gilchrist (1999) or the household collateral constraint mechanism following the approach by Iacoviello (2005).<sup>12</sup>

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<sup>12</sup> In chapters 4, 5 and 6 we reference various studies that use DSGE models with financial sector dynamics to study fiscal, capital reversal and leverage requirements shocks.

In the financial accelerator mechanism proposed by Bernanke, Gertler, and Gilchrist (1999), a fall in net worth implies that borrowers have little wealth to contribute to project finance. This creates a potential divergence between the interests of borrowers and lenders, which increases agency costs in the presence of asymmetric information. The probability of default increases as the company has less of its own funds involved in the project. The higher agency costs require that the lenders are compensated through higher premiums, which increase the external finance constraints for firms. In a second-round effect, the higher premiums lead to a further reduction in net worth and amplify the initial effect. This effect can start with a fall in economic activity, which reduces cash flows, asset prices and profits, reducing net worth. Bernanke, Gertler, and Gilchrist (1999) illustrate the impact of a government expenditure shock in their model. The presence of the financial accelerator mechanism magnifies the impact of an increase in government expenditure, mainly through its impact on asset prices and the related increase in firms' net worth.

There are various criticisms that have been raised against DSGE models. Some of them criticise the assumptions, whereas others criticise the claims made by DSGE modellers with regard to the model's suitability to study policy questions. Sims (2006), Caballero (2010) and Blanchard (2016) criticise DSGE models for their simplified assumptions of a representative firm and household; their estimation approach, which assumes that coefficients are the same across economies; and economic behaviour, which is often not in line with empirical evidence. Economies are much more complex, comprising an array of consumers and firms with different characteristics and different expectation formation processes. There is increasingly more evidence that expectations tend to be characterised by bounded rationality rather than perfect rationality as assumed in current DSGE models.<sup>13</sup>

These points are echoed by Tovar (2009), who also argues that DSGE models have failed to build in a sufficient representation of the financial sector including modelling of financial frictions and relationships such as financial development and trade. Heterogenous and systemic risks are not captured (Borio and Zhu 2012; Duca and Muellbauer 2014). Financial sector dynamics rely on profit-maximising banks

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<sup>13</sup> For more information on bounded rationality see Simon (1955). For a survey of the literature see Hommes (2011).

in the most recent models. This, however, has limited relevance to reality where banks are restricted in their ability to optimise by various types of regulation (Van den Heuvel 2002). The models are linear and thus cannot capture the boom and bust dynamics that characterise the financial sector (Duca and Muellbauer 2014). DSGE models do not model consistently the financial stocks and flows of economic agents. This makes them less suitable to study questions involving the transmission of shocks from the financial sector to the real economy. Some of the DSGE weaknesses are a function of computational problems. Adding more detail to the model requires greater computational power which is simply not available with current computers and mathematical software packages (Rudebusch, Sack, and Swanson 2006). The Bayesian econometrics used to estimate them allows for better calibration of parameters but at the cost of having a smaller system.

Solow (2010) criticises DSGE models based on their assumptions of voluntary unemployment, which should not be present if agents are rational.

### **3.1.2 Stock and Flow Consistent (SFC) modelling**

An alternative approach to DSGE models are the stock and flow consistent (SFC) models associated with the work of James Tobin and Wynne Godley (Backus *et al.* 1980; Godley and Cripps 1983). Current SFC models are dynamic, but not stochastic. They have no representative household or firm and therefore no optimisation of welfare or profit takes place. They have price and wage rigidities, which are, however, differently specified to DSGE models. Market clearing takes place through inventories rather than prices. Agents in SFC models can have rational or adaptive expectations. The framework has been used by both mainstream and heterodox economists, though over the last 20 years stock and flow models have been synonymous with the Post-Keynesian school.<sup>14</sup>

The key financial sector characteristics of stock and flow models as described by Godley and Lavoie (2012) are:

- *Track the evolution of stocks and precision regarding time.* This is an outcome of using the stock-flow coherent approach. Certain logical relationships built in the system guide and constrain its dynamics. They lead

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<sup>14</sup> Caverzasi and Godin (2015) provide a comprehensive review of the evolution of post-Keynesian stock and flow models and their applications to economic questions.

to its evolution over time. Within period and between period determination of macroeconomic variables follows dynamic sequencing, based on these stock and flow consistent relationships.

- *Use of several assets and rates of return.* This reflects the complexity and importance of financial relations in the modelling framework. The specification of relationships is largely based on Backus *et al.* (1980), who showed how the asset demand/allocation changes based on changes in the various returns. Households and firms are assumed to formulate long-term target asset and wealth positions. Actual positions are adjusted towards these targets.
- *Recognition of the importance of modelling the financial and monetary policy operations.* This includes the asset and liability accumulation decisions of monetary authorities and the government.
- *Strict budget constraints.* Agents must respect their budget constraints with respect to their expectations as well as when they assess their realised results. This along with the stock-flow consistency ensures a water-tight accounting framework, where the transaction flows of a particular sector are determined by the flows of other sectors. For example, in the case of portfolio choice with several assets, any change in the demand for an asset due to changes in the expected or end-of-period wealth must be matched by corresponding changes in the overall value of the remaining assets. This change must be of equal size but opposite sign.

Households in the current Post-Keynesian SFC have no micro foundations. Their expectations are not rational and asset accumulation decisions follow consumption decisions.

Producing firms make decisions based on their expectations of what will be demanded. This also drives the accumulation of inventories. Investment is driven by expected sales and in some studies by Tobin Q dynamics (see, for example, Zezza and Dos Santos (2004) and Taylor (2009)). Pricing is not used to clear markets. The unit costs are calculated and then a margin is calculated to achieve the target level of profit. This determines the overall price levels.

Banks play an important role in providing loans which fund inventory accumulation. SFC models can handle compulsory reserve requirements, capital adequacy ratios, Central Bank advances and bank equity. Thresholds could also be introduced, whereby consumer and firm credit is cut off whenever some ratio is exceeded. This allows the framework to introduce discontinuities (non-differentiable functions) in the solution process. In terms of monetary authorities' behaviour, the Central Bank sets the bill rate through purchasing and selling any residual amount of Treasury bills (bonds). In addition, the entire system is accommodative as financial liabilities are supplied on demand. This specification makes these models unsuitable to study credit constraints as the system always provides the required funding. The models are generally demand driven, with supply adjusting.

Burgess *et al.* (2016) highlight the benefits of stock and flow models over DSGE models. They argue that stock and flow consistent models are more realistic in terms of behaviour; have better specification of expectations; have a more important and realistic role for financial assets and institutions; have a more realistic feedback between the financial sector and the real economy; are better suited to study the evolution of gross and net financial positions; and can reach different steady states in response to shocks. They also highlight some of the problems associated with stock and flow consistent models compared to DSGE models. These include model equations, which are not linked to the optimisation problem of a particular agent, have high levels of complexity given the requirement for stock and flow consistency, large data requirements and parameters which are subject to the Lucas critique.

A number of recent studies develop stock and flow consistent models. Barwell and Burrows (2014) employ the stock and flow consistent approach to study the evolution of the UK economy in the years leading to the financial crisis of 2008. They stress the importance of balance sheet linkages in identifying financial fragilities. Caiani, Godin, and Lucarelli (2014) apply the stock and flow approach to Schumpeterian economic development. They analyse the monetary dynamics that emerge because of a structural change in the economy driven by innovation. The work is extended by Caiani, Godin, and Lucarelli (2015). Burgess *et al.* (2016) develop a stock and flow consistent model for the United Kingdom and use it to

study the impact of higher house prices, risk-weighted capital ratio, government consumption and sudden stop shocks. In terms of their shocks, their work is similar to ours.

### **3.1.3 Our framework**

Our framework is based on a simple computable general equilibrium model developed by Devarajan and Go (1998). This makes our framework similar to current DSGE models and different from current SFC models. Consumption and production behaviour are micro founded. This allows us to capture how changes in preferences, technology and resource constraints affect outcomes. The model framework has intertemporal optimisation. In addition, we incorporate a monetary policy reaction function based on a Taylor rule. Prices exhibit a degree of stickiness. The model, however, is not stochastic and we do not use Bayesian techniques to estimate the coefficients. The model's similarities to DSGE models also make it subject to similar criticisms. While we are not able to address all of them, the incorporation of stock and flow dynamics addresses some of the concerns raised with respect to the financial sector specifications.

It is the introduction of stock and flow dynamics that makes our framework similar to stock and flow models in the tradition of Backus et al. (1980). The behaviour of households, firms, banks, government and the monetary authorities is significantly different from the model specification of Godley (1996). For example, the behaviour of banks does not accommodate demand for loans. Rather the management of risk by the financial sector has important implications for lending rates and borrowing in the economy and economic activity.

Unlike current DSGE models, we model several financial instruments in a stock and flow consistent way. The presence of balance sheets is important in addressing the three questions that we raise in Chapter 1. Calvo, Izquierdo, and Mejia (2004) argue that balance sheet effects are important in the transmission of sudden stop shocks. Eggertsson and Krugman (2012) argue that the distribution of debt is important as the constraints faced by agents with high debt are different from those faced with low debt. The distribution of debt is important in determining the size of the fiscal multiplier, as we illustrate in Chapter 5, and it requires a more comprehensive representation of balance sheets than what is currently present in

DSGE models . The impact of higher capital on the behaviour of banks also requires more explicit modelling of balance sheets and financial flows following on the transmission mechanism identified by Borio and Zhu (2012).

Fundamental to our work are the theoretical frameworks developed by Woodford (2010) and Borio and Zhu (2012). We provide more detail on the two models in the next section.

Our specification of household expectations is different from DSGE and SFC models. Households have model-consistent expectations over a time scale of ten periods (the consumer is not infinitely foresighted); however, the expectations process can change from period to period and different rules can be introduced. This is more in line with recent research, which indicates that households tend to have bounded rationality (Hommes 2011; Roos and Luhan 2013). Bounded rationality is based on the seminal work of Simon (1955)<sup>15</sup>, who argues that economic agents do not follow the same basic process in making decisions; rather their expectations depend on what the situational context is, how it emerges and how reasoning operates within this context for different agents.

We illustrate how our specification of expectations can be used to introduce discontinuities in economic behaviour in Chapter 4, which we argue are important in understanding the impacts of sudden stop shocks.

The discussion above indicates that while our framework is stock-and-flow consistent, it is significantly different behaviourally from the recent model developed by Burgess *et al.* (2016). Some of the key differences include the presence of optimising households, model-consistent expectations and the presence of the financial accelerator mechanism.

Our study is also significantly different from the work of Duca and Muellbauer (2014). While they emphasise the importance of endogenising asset flows and prices in economic models, their emphasis is only on household consumption. Their approach is to estimate a household consumption function using the household

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<sup>15</sup> For more information, see Simon (1982) and for criticism of rational expectations, see Simon (1986).



flow-of-funds account, identifying the financial effects that impact consumption. The framework is not stock-and-flow consistent.

### **3.1.4 The theoretical models of Borio and Zhu and Woodford**

The model developed by Borio and Zhu (2012) presents a framework which explains how regulatory capital requirements affect the behaviour of the financial sector. In their model, the impact of higher capital requirements affects the financial sector directly through the *capital threshold effect* and the *capital framework effect*. The *capital threshold effect* arises because breaching the minimum threshold is costly for a bank. In the face of a possible breach, banks will take defensive action to avoid the high costs, which will affect the availability and pricing of funding extended to customers. This can translate into an increase in lending spreads. The effect is particularly strong and can affect the ability of the financial sector to extend credit when increasing the capital base is more costly than alternative funding sources at the margin.

The *capital framework effect* influences the way the banks measure, manage and price risk, which affects their behaviour. The economic cycle changes the strength of the capital threshold effect as probabilities of default, valuations and the perception of risk change. In turn, this shifts the relative position of the banks' capital to the regulatory threshold and affects bank behaviour. This can increase lending, improve net worth of agents across the economy and support economic activity further, creating a multiplier effect. The mechanism is affected by the response of monetary authorities as interest rates affect cash flows, net interest rate margins, earnings and the valuation of assets, which again affect the relative position of the bank capital relative to the regulatory threshold. Reductions in the policy rate can decrease the returns from certain assets and encourage risk taking in order to achieve pre-specified target rates of return. Monetary policy can also affect risk behaviour through communication policies and the central bank reaction function. Through its actions the Central Bank can increase transparency, reduce uncertainty and compress risk premia. The perception that the central bank reaction function is effective in reducing downside risks can increase risk taking. The impact depends on the composition of balance sheets and the financing constraints faced by agents in the economy. This mechanism also operationalises the risk-taking

channel in the framework, which is defined as the impact of changes in policy rates on either risk perceptions or risk-tolerance.<sup>16</sup>

Liquidity and risk-taking are tightly interconnected and can reinforce each other. Lower perceptions of risks and higher risk tolerance weaken external funding and transferability constraints and hence increase liquidity. At the same time, weaker liquidity constraints can support higher risk-taking.

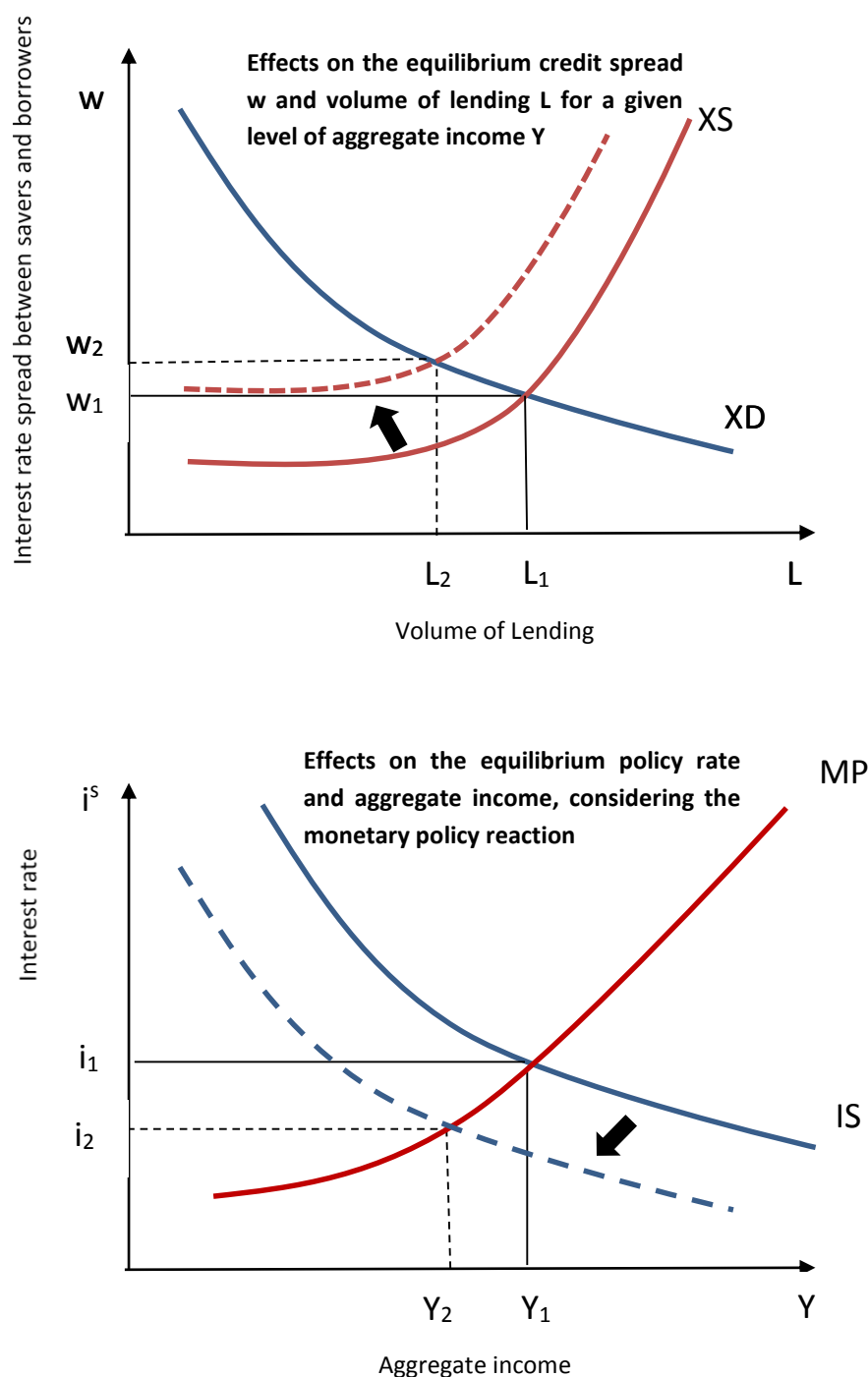
The financial accelerator mechanism in the framework developed by Borio and Zhu (2012) works through the regulatory regime; the impact of the cycle on probabilities of default, valuations and the perception of risk; and the monetary policy decisions as explained above. In addition, the mechanism is supported by the mutually reinforcing relationship between risk-taking and liquidity.

Woodford (2010) presents a theoretical framework which links the capital of the intermediaries, the supply of intermediation services and economic activity. The willingness of financial intermediaries to provide services depends on the lending spread, the margin that they can charge over the interest rate paid to savers. The lending spread reflects the marginal costs of intermediation. These costs are an increasing function of the volume of lending as intermediaries have limited capital. Increasing capital is likely to be costly, and increasing leverage is limited by regulatory capital requirements. Raising funds through loans is constrained by the intermediaries' collateral. This indicates that for a given quantity of capital, the supply schedule for intermediation services will be upward sloping as XS in Figure 3.1. The demand for intermediation is represented by the schedule XD. It shows the willingness of borrowers to pay to induce savers to supply funds. This is a profit opportunity for the intermediaries to the extent that the cost of intermediation is low. The schedule XD reflects a certain level of income. Changes to income shift the demand for intermediation. This establishes a relationship between interest rates, income and the level intermediation, which is represented as an IS curve in the second panel of Figure 3.1.

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<sup>16</sup> The presence of the risk taking channel is supported by empirical studies such as Adrian and Shin (2010).

Figure 3.1: Graphical representation of the model (Woodford 2010)



Source: adopted from Woodford (2010)

Shocks that impair the capital of the intermediary or higher regulatory leverage ratio requirements will shift the  $XS$  curve up and to the left. The equilibrium credit spread increases and the volume of lending declines for any given level of economic activity ( $Y$ ). This implies that the rate paid to savers declines while the rate paid by

borrowers rises for the given level of  $Y$ . This is true for each possible value of  $Y$ , which leads to a shift in the IS curve down and to the left.<sup>17</sup> If the monetary policy reaction function (represented by MP) remains the same, the shift of the XS curve leads to lower policy rate and a decline in economic activity.

The framework can generate financial accelerator effects. For example, the initial decline in economic activity is likely to reduce the net worth of financial intermediaries and the volumes of loans for any given credit spread. This will shift the XS curve further to left. The secondary effects if caused by changes to the capital of the intermediary are likely to be more persistent than the initial shock. If intermediaries are required to sell assets in a systemic manner, this can create a vicious spiral that reduces the capital of intermediaries and loan supply.

We view the two frameworks as complimentary and fundamental to our analysis. Woodford (2010) provides an explicit link between bank capital, level of intermediation, interest rate spreads and economic activity. The analysis of Borio and Zhu (2012) provide more support why intermediaries may be facing an upward sloping supply curve for intermediation services and links the risk taking behaviour of the financial sector, which is a source of financial accelerator effects, to how it measures, manages and prices risk. This is not only a function of the balance sheet of the financial sector, but rather of how the financial sector views the distribution of risk across the economy and the balance sheets of all institutions.

### 3.2 Detailed Model Description

We now present our framework comprising of a small general equilibrium model with financial stock and flow dynamics.<sup>18</sup> The model structure builds on the work of Devarajan and Go (1998), Tobin (1982) and Godley and Lavoie (2007). There are six types of institutions that make real and financial decisions:

- the representative household,
- government,
- the Central Bank,
- the representative financial corporation,
- the representative non-financial corporation and

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<sup>17</sup> The IS schedule plots the equilibrium value of the rate paid to savers ( $i^s$ ) because the policy reaction function targets  $i^s$  rather than the rate paid by borrowers.

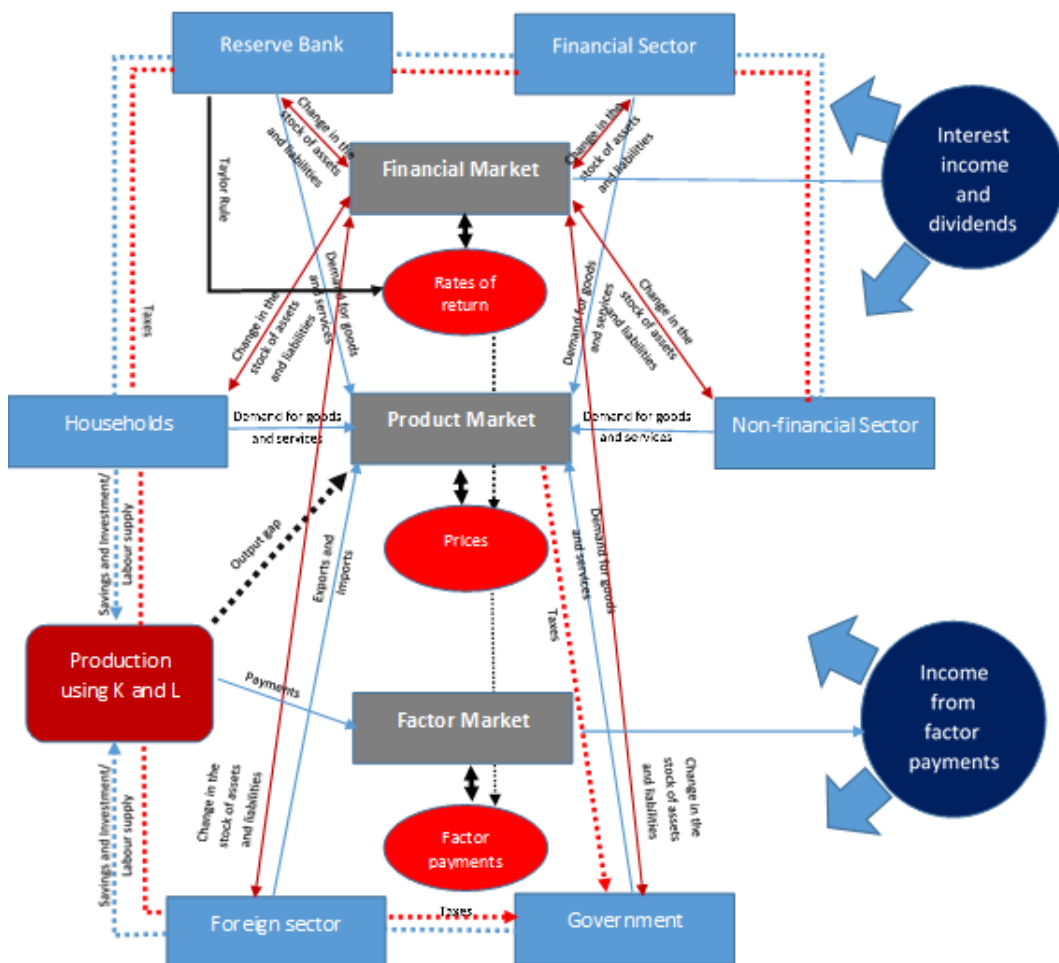
<sup>18</sup> All the model equations, variables and parameters are presented in the appendix of this chapter.

- the rest of the world.

The financial instruments are grouped in five categories: equities, loans, cash and deposit, bonds and other. Figure 3.2 presents the conceptual framework.

The different agents meet in the financial, product and factor markets.

**Figure 3.2: Diagrammatic representation of the model framework**



In the financial market, decisions are made regarding the accumulation of financial assets and liabilities. These are represented by the maroon lines labelled *Changes in the stock of assets and liabilities*. There are sub-markets for money, bonds, equities and loans. The markets are linked through a set of asset demand functions and stock and flow equilibrium rules, which ensure that stock and flow consistency is always maintained. The markets for bonds and loans are cleared through their rates of return, while the markets for money and equities are cleared *on demand*. The financial sector and the non-financial sector provide money and equities to ensure that demand is equal to supply. The rates of return are affected by the policy

rate which is determined by the Reserve Bank. It is assumed that the monetary authorities follow a Taylor rule (the black line labelled *Taylor rule*).

The financial market also distributes net dividend and interest income (represented by the large dark blue circle) to all institutions.

Changes in an agent's asset portfolio are equal to the changes in the financial wealth. This, in turn, is a function of financial wealth from the previous period, capital gains, changes to the stock of liabilities and net saving. Decisions to invest in financial assets are driven by the level of economic activity as well as the rates of return and costs associated with holding liabilities. The foreign and financial sectors make their decisions based on relative returns, following Tobin asset demand functions.

In the product market, the supply of goods and services is driven by producers maximising profits subject to a CES production function. We have one domestically produced good. Demands arise from the household, government, investment and net exports. These are represented by the blue lines labelled *Demand for goods and services*. Prices of imports, exports and the domestically produced good adjust to ensure flow equilibrium in the product market. These are represented in the diagram by the red circle labelled *Prices*.

In the factor markets, the demands for capital and labour are driven by the real borrowing costs in the economy as well as the deviation of aggregate demand from its steady state. The economy -wide production function represented by the maroon square employs the factors of production and makes factor payments, which are distributed to the capital owners and labour (the second dark blue circle labelled *Income from factor payments*). The real borrowing costs reflect the prevailing credit conditions and, along with aggregate demand, proxy the current economic conditions. Higher real rates reduce the demand for factors of production directly and indirectly through their impact on aggregate demand. Labour demand tends to be more sensitive to changes in real borrowing costs and aggregate demand than capital as capital is generally activity specific and thus immobile. The factor returns adjust reflecting the imperfect substitutability of capital and labour. These are represented by the red circle labelled *Factor Payments*. Underutilisation of production factors represents a negative output gap and lower supply of goods and

services than the potential of the economy (the black dotted line labelled *Output Gap*). The level of investment by each institution (the dotted blue line) determines the stock of capital employed in the production function. Labour is assumed to grow at an exogenous growth rate.

The three markets are linked through:

1. The impact of balance sheet changes on real lending rates and the subsequent effect on the demand for goods and services and factors of production. This channel works primarily through the net worth of the financial sector, the lending spread, investment and household consumption. This also affects the demand for factors of production.
2. Inflation and its impact on asset prices and monetary policy decisions.
3. Financial assets, which generate dividend and interest income. These and other income sources generate demand for goods and services as well as demand for financial assets and liabilities in the next period.
4. And finally, economic activity and its impact on asset prices and demand for assets and liabilities as well as factors of production.

Similar to Devarajan and Go (1998), the model includes three macroeconomic balances: the government balance, the external balance and the savings-investment balance. These are in addition to accounting rules that ensure stock and flow consistency on the financial side.

The financial sector provides intermediation services. Its demand for assets is represented by a Tobin asset demand function. Its decisions to accumulate assets and liabilities and hold reserves drive the lending spread and contribute to equity price growth. The level of reserves held by the financial sector is a main determinant of the credit multiplier, a key component of our financial accelerator mechanism.

The non-financial sector is responsible for the bulk of investment in the economy, which is driven by a Tobin-Q specification. The sector provides equities on demand, which help fund its investment expenditure and demand for financial assets.

Government receives direct and indirect taxes (represented by the dotted red lines) in addition to factor income, dividends, interest income, social contributions and

other income. The government consumption expenditure is determined by a discretionary growth rate. The change in the stock of bonds issued by the government closes the government flow balances.

The external sector interacts with the domestic economy in both the financial and product markets. Exports and imports are modelled as imperfect substitutes to the domestically produced good and are driven by changes in relative prices. Some of the foreign liabilities of the domestic economy are fixed in foreign currency units, while others vary with the level of domestic economic activity. The exchange rate ensures the closure of the external balance. It also affects the liability side of the foreign sector (expressed in local currency units) and along with exogenous changes to foreign savings leads to changes in the financial wealth of the external sector.

The household maximise consumption subject to a future wealth target and all equations in the model. The target is based on an exogenous growth rate, which indicates the real wealth that the representative household would like to achieve in the future given its current level of wealth. For simplicity, the wealth target assumption is adopted in the tradition of Pigou's real wealth effect (Patinkin 1948; Tobin 1975).<sup>19</sup> The household receives factor income, dividends, interest income, social contributions and other income. It makes decisions about consumption (savings), investment and asset and liability accumulation.

The model assumes that savings by the financial and non-financial sector adjusts to ensure that the savings-investment balance is maintained.

The micro-foundations of the model make it significantly different from current stock and flow models in the tradition of Godley and Lavoie (2007) and closer to standard DSGE models. At the same time, the requirement of stock and flow equilibrium on the financial and on the real sides and the absence of rational

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<sup>19</sup> In their stock and flow consistent models, Godley and Lavoie (2012) employ a specification with a level of wealth expected at the end of the period that is based on the actual wealth in the previous period plus the level of expected savings. The level of expected wealth is a driver of the demand for assets. In our specification, the target level of wealth also drives the household demand for assets. However, the target is a function of an exogenous growth rate and real wealth achieved in the previous period. Households also optimise intertemporally unlike the models developed by Godley and Lavoie. The growth rate is assumed exogenous in order to simplify the dynamics of the model. An endogenous growth provides an additional channel for households to respond to the shocks in the macroeconomy.



expectations differentiate our framework from current DSGE models. What follows is a detailed representation of the model.

#### *Producer behaviour*

The modelling of production, exports and imports follows closely Devarajan and Go (1998). There is only one representative producer. A constant elasticity of substitution (CES) production function is maximised subject to a given set of input and output prices. We assume constant returns to scale in line with neoclassical theory:

$$QVA_t = \alpha^p \cdot \left( \sum_f \delta_f^p \cdot QF_{tf}^{-\rho^p} \right)^{-1/\rho^p} \quad (1)$$

where  $QVA$  is the value added in period  $t$ ,  $\alpha^p$  is a shift parameter reflecting total factor productivity (TFP),  $QF$  is the quantity demanded of each factor  $f$  (i.e., labour and capital), and  $\delta^p$  is a share parameter of factor  $f$  employed in the production process. The elasticity of substitution between factors  $\sigma_i^p$  is a transformation of  $\rho^p$  (i.e.,  $\sigma_i^p = 1/(1 + \rho_i^p)$ ). The factor demand equation is:

$$QF_{tf} = \alpha^p^{-\frac{\rho^p}{1+\rho^p}} \cdot QVA_t \cdot \left( \delta_f^p \cdot \frac{PVA_t}{WF_{tf}} \right)^{1/(1+\rho^p)} \quad (2)$$

Intermediate inputs are a fixed share of valued added. Total aggregate output is equal to the sum of value added and intermediate demand.

#### *Behavioural functions governing international trade*

Imports are modelled using an Armington specification (Armington 1969). Imported and domestically produced goods are imperfect substitutes. Changes in the relative price of imports lead to a change in the ratio of imports to domestic sales:

$$QQ_t = \alpha^q \left[ \delta^q \cdot QD_t^{-\rho^q} + (1 - \delta^q) \cdot QM_t^{-\rho^q} \right]^{-1/\rho^q} \quad (3)$$

$$(1 - ts_t) \cdot PQ_t \cdot QQ_t = PD_t \cdot QD_t + PM_t \cdot QM_t \quad (4)$$

$$PM_t = (1 + tm_t) \cdot pwm_t \cdot EXR_t \quad (5)$$

where  $ts_t$  is an indirect sales tax,  $\alpha^q$  is a shift parameter,  $\delta^q$  is a share parameter,  $QQ$  is the composite good consumed domestically at time  $t$ ,  $QD$  and  $QM$  are domestically supplied and imported quantities, and  $PD$  is the price of domestic good  $QD$ . The import price  $PM$  is determined by world import prices  $pwm$ , import tariff rates  $tm$  and the exchange rate  $EXR$ , under the small country assumption,  $pwm$  and  $tm$  are exogenous variables.  $PQ_t$  is the composite supply price.

A constant elasticity of transformation (CET) function determines the relationship between the quantity of goods produced for domestic and foreign export markets:

$$QA_t = \alpha^t \left[ \delta^t \cdot QD_t^{\rho^t} + (1 - \delta^t) \cdot QE_t^{\rho^t} \right]^{1/\rho^t} \quad (6)$$

$$PA_t \cdot QA_t = PD_t \cdot QD_t + PE_t \cdot QE_t \quad (7)$$

$$PE_t = (1 - te_t) \cdot pwe_t \cdot EXR_t \quad (8)$$

where  $QE$  is the quantity of exports,  $te$  is the export tax rate (negative if a subsidy), and  $pwe$  is the exogenous world export price,  $\alpha^t$  is a shift parameter and  $\delta^t$  is a share parameter.  $PE_t$  is the export deflator, which is a function of the world prices, the exchange rate and the export tax.

The above equations lead to the following first order conditions which define the ratio of  $QD$  to  $QM$  and the ratio of  $QD$  to  $QE$ :

$$\frac{QD_t}{QM_t} = \left( \frac{\delta^q}{1 - \delta^q} \cdot \frac{PM_t}{PD_t} \right)^{1/(1+\rho^q)} \quad (9)$$

$$\frac{QD_t}{QE_t} = \left( \frac{\delta^t}{1 - \delta^t} \cdot \frac{PE_t}{PD_t} \right)^{1/(\rho^t-1)} \quad (10)$$

#### Prices

In this section, we outline the specifications driving prices other than  $PE$  and  $PM$ , which were described above.

$$PQ_t = (1 + inf) \cdot PQ_{t-1} + \theta_1^{pq} \cdot (y_{t-1}^{gap,l} - 1) + \theta_2^{pq} \cdot \Delta PM_t \quad (11)$$

$PQ$  is the supplier price excluding sales taxes. It is also the numeraire price in our framework, affecting all other prices.  $inf$  is the target rate of inflation, which also proxies steady state inflation. The proxy variable for the output gap  $y_{t-1}^{gap,l}$ , which is described below and the change in import prices  $\Delta PM_t$  affect inflation. The coefficient  $\theta_1^{pq}$  measures the responsiveness of prices to the output gap, while the coefficient  $\theta_2^{pq}$  measures the responsiveness of prices to changes in import prices. The equation reflects Phillips curve dynamics.

The sales price including sales taxes is related to  $PQ$  via the simple identity:

$$PRC_t = (1 + ts_t) \cdot PQ_t \quad (12)$$

The prices of domestically produced output  $PD$  is determined in equation 13. It is a function of the nominal value of the composite output, nominal imports and real output of the domestically produced good.

$$PQ_t \cdot QQ_t = PD_t \cdot QD_t + PM_t \cdot QM_t \quad (13)$$

The activity price  $PA$ , which is inclusive of activity taxes  $ta$ , is defined similarly in the equation below.

$$PA_t \cdot QA_t = PD_t \cdot QD_t + PE_t \cdot QE_t \quad (14)$$

The value-added price is a function of the nominal activity output after tax minus the nominal value of intermediates over real value added.

$$PVA_t \cdot QVA_t = PA_t \cdot (1 - ta_t) \cdot QA_t - PRC_t \cdot QINTA_t \quad (15)$$

Our specification of price expectations is a significant departure from current mainstream economics and DSGE models. Empirical evidence does not support assumptions of rational expectations (Amano, Engle-Warnick, and Shukayev 2011; Dias, Duarte, and Rua 2010; Johannsen 2014; Mankiw, Reis, and Wolfers 2003). For South Africa, Kabundi and Schaling (2013) also dismiss the assumption that inflation expectations are rational. We therefore model inflation expectations as adaptive. Equation 16 specifies how price expectations are formed. The coefficient  $\theta^p$  captures the response of expectations to deviations of expected from actual

prices. More credible monetary policy implies a smaller coefficient. The coefficient  $\theta^{prce}$  measures the sensitivity of expectations to changes in the output gap and it is significantly smaller compared to the coefficient  $\theta_1^{pq}$ . While inflation expectations are directly affected by the level of economic activity, this impact is significantly smaller than the direct impact on inflation.

$$PRC_t^e = (1 + inf) \cdot PRC_{t-1}^e - \theta^p \cdot (PRC_{t-1}^e - PRC_{t-1}) + \theta^{prce} \cdot (y_{t-1}^{gap,l} - 1) \quad (16)$$

The equity price is a function of the steady state growth rate  $ss^{peq}$ ; expected inflation, which affects the equity price with elasticity  $\mu_1^{peq}$ ; the change in the stock of money supply created by the financial sector  $SL_t^{fin.cd}$  (a proxy for money supply growth), which affects the equity price with elasticity  $\mu_2^{peq}$ ; and the change in aggregate output, with elasticity  $\mu_3^{peq}$ . These have been identified as important drivers of equity prices (Chen, Roll, and Ross 1986; Rapach, Wohar, and Rangvid 2005). For South Africa, Gupta and Modise (2013) find that interest rates, money supply and world oil production growth affect stock prices.

$$PEQ_t = \left( (1 + ss^{peq}) \cdot (1 + \pi_t^e)^{\mu_1^{peq}} \cdot (\Delta SL_t^{fin.cd})^{\mu_2^{peq}} \cdot (\Delta QA_t)^{\mu_3^{peq}} \right) \cdot PEQ_{t-1} \quad (17)$$

#### *Investment and savings*

Most of the investment in our framework is done by non-financial enterprises. Their investment is defined in equation 18.

$$I_t = I_{t-1} \cdot \gamma_1^I \cdot \left( \frac{\Delta PEQ_t}{\Delta PRC_t} \right)^{\gamma_2^I} \cdot \left( \frac{1 + r_t^l}{1 + \pi_t^e} \right)^{\gamma_3^I} \quad (18)$$

Investment in every period is linked to past investment through the fixed coefficient  $\gamma_1^I$ . In addition, investment in the current period varies with the change of equity prices to overall prices and the real rate on loans.  $\gamma_2^I$  and  $\gamma_3^I$  are elasticities, which measure the responsiveness of investment to the two terms. The term  $\left( \frac{\Delta PEQ_t}{\Delta PRC_t} \right)$  captures Tobin Q effects. Higher equity prices relative to prices of goods and services (a proxy for the book value of the firm) leads to higher investment.

Investment by other institutions such as the household and the financial sector is modelled similarly without the Tobin Q effects.

The savings of the household sector are defined as after tax income minus household consumption and other expenditure:

$$SAV_t^H = (1 - td_t^H) \cdot PRC_t \cdot YI_t^H - SC_t^H - OI_t^H - IEXP_t^H - PRC_t \cdot QH_t \quad (19)$$

where  $YI_t^H$ ,  $SC_t^H$ ,  $OI_t^H$ ,  $IEXP_t^H$ ,  $QH_t$  are respectively real household income, social contributions made by households, other contributions, interest rate expenditure and real household expenditure.

Savings for the financial and non-financial sector adjust to ensure that the savings and investment constraint is maintained.

$$SAV_t^{ii} = MPS_t^{ii} \cdot (1 - td_t^i) \cdot PRC_t \cdot YI_t^{ii} \quad (20)$$

The set  $ii$  consists of the financial and non-financial sectors.  $MPS_t^{ii}$  is the marginal propensity to save defined as:

$$MPS_t^{ii} = mpsbar^{ii}(1 + MPSADJ_t) \quad (21)$$

The steady state marginal propensity  $mpsbar$  varies, driven by the term  $MPSADJ_t$ . Savings for the foreign sector are exogenous, while savings of the Central Bank is simply the after-tax income left after paying for interest expenditure.

#### *Financial behaviour*

The financial behaviour in our framework is based on the flow of funds dynamics. In every period agents experience a change in their financial wealth. This is driven by their decisions to accumulate liabilities (sources of funds), changes to the equity price and net savings. The financial wealth is then divided into different financial assets. Institutions that save more than they invest have net incurrence of financial assets which exceeds the net incurrence of financial liabilities. The opposite takes place if investment exceeds savings.

The equation defining financial wealth is:

$$FW_t^i = \sum_{fi} SA_{t-1}^{i,fi} + PEQ_t \cdot SA_{t-1}^{i,eq} + \sum_{fi} dl_t^{i,fi} + PEQ_t \cdot dl_t^{i,eq} + SAV_t^i - PRC \cdot I_t^i + n_t^i \quad (22)$$

where  $i$  is a set of agents consisting of the household, government, the Central Bank, financial sector, non-financial sector and the rest of the world. The set  $fi$  consists of the financial instruments cash and deposits, loans, bonds and other assets. We do not model prices for these instruments. We simplify our analysis by assuming that agents hold bonds to maturity.  $SA$  is the stock of assets,  $dl$  is a flow variable and it represents the change in the stock of liabilities. Changes to equity prices increase the value of equities and the funds available for financial investment.  $SA_{t-1}^{i,eq}$  is the stock of equities in the previous period.

Next, we discuss how the various institutions choose to divide their financial wealth across the different financial assets and how they increase their liabilities.

#### Assets

The asset demand specification for the financial and foreign sectors is based on a Tobin asset demand function (Backus et al. 1980; Godley and Lavoie 2007; Tobin 1982). The general specification is:

$$SA_{fii,t}^{it} = (FW_t^{it} - SA_t^{it,l}) \cdot \left( \lambda_{fii,0} + A_{fii,j} \cdot r_{fii,j} + \lambda_{fii,4} \frac{PRC_t \cdot YI_t^{it}}{FW_t^{it}} \right) \quad (23)$$

where the set  $it$  consists of the foreign and financial sectors, the set  $fii$  has the financial instruments equities, bonds and cash and deposits.  $\sum_{fii} \lambda_{fii,0} = 1$ ,  $\sum_{fii} \lambda_{fii,4} = 0$ ;  $A$  is a matrix of coefficients which satisfies  $\sum_{fii} A_{fii,j} = 0$ ;  $j$  is equal to the number of financial instruments, in this case three, and  $\sum_j A_{fii,j} + \lambda_{fii,4} = 0$ . The coefficients of matrix  $A$  show the responsiveness of the holding of a financial instrument as an asset to changes in its own return as well as the returns of other assets. An increase in the return of equities, which is a function of equity prices, and current period dividend payments, relative to the return on money and bonds, increases the demand for equities and their relative share in the financial sector portfolio. This is at the cost of reducing the shares of money and bonds. This ensures that the share of one asset can increase only if the shares of other assets falls. The stock of loans  $SA_t^{it,l}$ , which is determined outside the Tobin function, is subtracted

from the total financial wealth  $FW$ . The coefficient  $\lambda_{fi,4}$  reflects the transactional demand for money, which is represented by the cash and deposit instrument in our framework. An increase in the share of nominal income relative to financial wealth should translate into a higher share of cash and deposit holding.

The stock of loans provided by the financial sector to the economy is a function of the deposits held by the financial sector in the previous period. Higher cash and deposits liability in the previous period translates into higher loans in the current period.

$$SA_t^{fin,loans} = (1 - RR_t) \cdot SL_{t-1}^{fin,cashdep} \quad (24)$$

The ratio  $RR_t$  is key to the operations in our model. It reflects the requirements by the Central Bank for the financial institutions to hold cash reserves, but it also reflects the financial sector's willingness to hold reserves for other reasons, such as to manage liquidity or risk. This aims to capture the mechanism identified by Borio and Zhu (2012). A decrease in the ratio can reflect higher willingness to take risk. A reduction in the ratio increases the supply of loans and reduces the lending spread. This in turn encourages investment in the economy and the building of capital stock. The  $RR_t$  ratio provides a link between the behaviour of the financial sector and the real economy. At the same time, developments in the real economy affect the ratio through the repo rate and the growth in the financial assets of the financial sector. The relationship in equation 24 also represents a money multiplier.

The ratio is calibrated by dividing the stock of loans on the asset side of the financial sector through the stock of cash and deposits on the liability side. Movements in the repo rate reflect changes in the cycle, which affect asset prices and the net worth of agents in the economy, including the financial sector. The repo rate affects bank lending directly and indirectly through the financial net worth. The growth in financial assets captures the prevailing financial conditions and is sensitive to changes in capital requirements. The introduction of higher capital ratio can lead to repricing of risk, reduction in the growth of financial sector assets and an increase in  $RR_t$ . Changes to the ratio affect all institutions through the loan supply by the financial sector and the lending spread. This in turn affects assets prices and

economic activity, creating feedback loops that operate through the balance sheets of all agents.

$\beta^{repo}$  is the responsiveness of the reserve ratio to changes in the repo rate, whereas  $\beta^{sa}$  is the responsiveness to changes to the growth in the balance sheet of the financial sector.  $fi$  is a set including all financial instruments. The equation below outlines the specification for the reserve ratio.

$$RR_t = RR_{t-1} \cdot (1 + \Delta r_{t-1}^{repo})^{\beta^{repo}} \cdot \left( \frac{\sum_{fi} SA_t^{fin,fi}}{\sum_{fi} SA_{t-1}^{fin,fi}} \right)^{\beta^{sa}} + \lambda_t^{rr} \quad (25)$$

This specification also aims to capture the mechanism identified by Woodford (2010). In his model, the IS curve links the loan spread to the demand and supply of intermediary services and the level of economic activity.<sup>20</sup> The supply of intermediary services, in turn, depends on the capital of intermediaries as well as factors that can loosen or tighten the leverage constraint, such as changing attitudes of intermediaries' creditors. Improvements to the net worth of the financial sector, for example, can increase the level of intermediation services, reduce the spread and increase economic activity. In our framework, the economic activity is captured through the repo rate, the attitudes of intermediaries' creditors is captured through the exogenous parameter  $\lambda_t^{rr}$  and the term  $\left( \frac{\sum_{fi} SA_t^{fin,fi}}{\sum_{fi} SA_{t-1}^{fin,fi}} \right)^{\beta^{sa}}$  accounts for balance sheet effects.

If the relationship between output and interest rates is elastic, the model framework can create financial accelerator effects.

The provision of loans by the rest of the world as well as by nonfinancial companies and government is a function of the financial wealth in the previous period and the repo rate. Higher repo rate decreases the share. This indicates that with increases in

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<sup>20</sup> In the baseline model and simulations, we keep the value of  $\lambda_t^{rr}$  set to zero. However, this requires a very large coefficient for  $\beta^{repo}$ . This can lead to the conclusion that monetary policy is highly effective. While monetary policy in our framework is more effective than in models with limited or no financial sector dynamics due to the mechanisms identified by Borio and Zhu (2012), the size of the coefficient in this case also reflects a simplification, assuming the factors captured by  $\lambda_t^{rr}$  are directly linked to monetary policy. An alternative specification is to reduce the size of  $\beta^{repo}$  and either exogenously or endogenously provide values for  $\lambda_t^{rr}$ .



the repo rate, the economy is likely to slow down and the credit worthiness of borrowers to deteriorate.

The demand for cash and deposits by households, the non-financial sector and government is driven by the real rate on cash and deposits as well as the nominal income of each institution. Higher real rates increase the demand for deposits as a store of value, while higher income increases the transactional demand:

$$SA_t^{il,cd} = \alpha^{il,cd} \cdot \left( \frac{1 + r_t^{cd}}{1 + \pi_t} \right)^{\mu^{cd}} \cdot PRC_t \cdot YI_t^{il} \quad (26)$$

where  $il$  is the set of agents,  $\alpha$  is the steady state coefficient, which links the stock of cash and deposit assets to nominal income,  $r_t^{cd}$  is the nominal rate on cash and deposit holdings and  $\mu^{cd}$  captures the responsiveness of cash and deposit holding to changes in the real rate. Our specification reflects the use of money for transaction purposes as well as store of value. The demand for cash and deposits by the Central Bank is kept exogenous.

Households also demand equities, while the demand for bonds is kept exogenous. Households have a low direct exposure to bonds in the underlying data. We assume a simple relationship where the stock of equities is equal to the financial wealth not invested in other assets. The household equity stock largely represents interests in retirement and life funds.

The demand for equities by the non-financial sector, government and the Central Bank is kept exogenous. The decision by government to hold equities is likely to be driven by discretionary policies while the Central Bank generally does not hold equities. In the case of the non-financial sector, our assumption aims to reduce the model complexity. The purchases of equities by this sector are also likely to be a function of various strategic considerations which go beyond equity returns. The demand for bonds by the non-financial sector is also kept constant, reflecting the decreasing direct importance of the sector in the bond market.

Government does not demand bonds as an asset. The Central Bank's demand for bonds is residual demand. It is based on the flow of funds identity:

$$\begin{aligned}
da_t^{rb,b} = & SAV_t^{rb} + \sum_{fi} dl_t^{rb,fi} + PEQ_t \cdot dl_t^{rb,e} - PEQ_t \cdot da_t^{rb,e} \\
& - \sum_{fib} da_t^{rb,fib} - PRC_t \cdot I_t^{rb}
\end{aligned} \tag{27}$$

where  $da$  is the change in the stock of assets and is defined over the set of financial instruments  $fi$ . Considering that the Central Bank's liabilities are made mainly of cash and deposits, the identity effectively reflects open markets operations. The bank expands money supply by purchasing bonds after accounting for net savings. This identity ensures that the supply and use of funds are equal. The same identity applies to all agents and ensures stock and flow consistency.

The *other* financial instrument is kept constant for all agents except the Central Bank. This is because we classify foreign reserves under other assets. For the Central Bank, the accumulation of other financial assets is given by the identity:

$$SA_t^{rb,oa} = EXR_t \cdot res + sa^{rb,oa} \tag{28}$$

$sa$  is the exogenous other assets of the Central Bank excluding foreign currency reserves. The reserves are represented in foreign currency units and are fixed ( $res$ ). The other assets ( $SA_t^{rb,oa}$ ) for the Central Bank fluctuate with changes in the exchange rate or discretionary policy decisions, which change the level of reserves.

#### *Liabilities*

The demand for loans on the liability side is modelled similarly to the demand for cash and deposits.

$$SL_t^{ins,l} = \alpha^{ins,l} \cdot \left( \frac{1 + r_t^l}{1 + \pi_t} \right)^{\mu^l} \cdot PRC_t \cdot YI_t^{ins} \tag{29}$$

The function represents the demand for loans for all institutions, except the foreign sector. The parameter  $\alpha^{ins,l}$  is fixed, while the demand fluctuates with changes in the real borrowing costs. The elasticity  $\mu^l$  is negative. For the foreign sector, we keep the loans a fixed share of domestic GDP lagged one period and expressed in foreign currency units. The fixed share is calibrated to the base year.

$$SL_t^{row,l} = \alpha^{row,l} \frac{PRC_{t-1} \cdot GDP_{t-1}}{EXR_{t-1}} \quad (30)$$

Government is the only institution that issues bonds. This reflects the information in our underlying data. The issuance of bonds is driven by government's decision to consume, save, invest and accumulate financial assets and liabilities. The specification reflects the flow of funds identity with bonds on the liability side being the balancing item.

The issuance of equities is modelled endogenously for the financial, nonfinancial and foreign sectors. The equity issuance for the financial sector varies directly with the accumulation of equities by the household sector.

$$SL_t^{fin,e} = sl^{fin,e} + SA_t^{H,e} \quad (31)$$

Our definition of equities includes *interests in retirement and life funds*, which is the main financial asset of households and sits on the financial sector balance sheet as a liability. The other equity liabilities of the financial sector are exogenous ( $sl^{fin,e}$ ).

The nonfinancial sector supplies equities on demand similar to the specification in Godley and Lavoie (2007). The set *infin* includes all agents except non-financial institutions. Changes to equity prices and dividend payments affect the demand for equities, leading to changes in the supply of equities by the non-financial sector. This ensures that the supply and demand for equities is equal.

$$SL_t^{nfin,e} = \sum_i SA_t^{i,e} - \sum_{infin} SL_t^{infin,e} \quad (32)$$

The foreign sector equity liability is also a constant share of GDP (expressed in foreign currency units), modelled similarly to the loan liability.

Cash and deposits are created by the Central Bank and the financial sector. The Central Bank expands its money supply according to the equation below:

$$SL_t^{cb,cd} = \sigma^{cb,cd} \cdot \sum_i PRC_t \cdot YI_t^i \quad (33)$$

The stock of cash and deposit liabilities of the Central Bank grows with the total nominal income in the economy. Higher national income translates into greater

transactional demand for money. We assume that the relationship is constant and captured through the coefficient  $\alpha^{cb,cd}$ . The financial sector accommodates the demand for cash and deposits.

The *other* liabilities are fixed for all institutions except the foreign sector as the foreign reserves, which fall on the asset side of the Central Bank's balance sheet, fall on the liability side of the foreign sector.

#### Interest Rates

The policy rate is the repo rate set by the Central Bank. We use a Taylor rule specification, similar to de Jager, Johnston, and Steinbach (2015), though our coefficients are of different size, and we use deviations from actual inflation rather than inflation expectations. In our framework, inflation expectations are adaptive and thus the current specification also captures the relationship between the policy rate and inflation expectations:

$$\begin{aligned} r_t^{repo} = & \rho^{repo} \cdot r_{t-1}^{repo} + (1 - \rho^{repo}) \cdot (inf + \beta_2^{repo} \cdot (\pi_t - inf) \\ & + \beta_3^{repo} \cdot (y_{t-1}^{gap,l} - 1)) \end{aligned} \quad (34)$$

where  $r_t^{repo}$  is the repo rate and  $y_t^{gap,l}$  is a proxy for the output gap, which measures the capacity utilisation of labour. Interest rate decisions affect all other interest rates. While we capture the traditional channels of monetary policy mechanism, our framework also has features which capture the intermediation-interest rate spread channel and the related risk-taking channel (Borio and Zhu 2012; Woodford 2010).

$$r_t^b = r_t^{repo} + dr_t^b \quad (35)$$

$$r_t^{cd} = \mu_2^{rcd} \cdot r_t^{repo} + (1 - \mu_2^{rcd}) \cdot r_t^l \quad (36)$$

$$r_t^l = r_t^{repo} + dr_t^l \quad (37)$$

The other interest rates modelled are for bonds ( $r_t^b$ ), cash and deposits ( $r_t^{cd}$ ) and loans ( $r_t^l$ ). In each case the interest rate is a function of the repo rate. The term  $dr$  fluctuates, bringing the supply and demand of the respective financial instrument into equilibrium. Unlike the equity market and the cash and deposit market, the markets for loans and bonds are brought into equilibrium via the respective interest

rate, which feeds into the asset demand functions described above. The term  $dr$  represents the interest rate spread.

A reduction in the supply of loans increases the lending spread over the repo rate and reduces demand for loans as explained above. The spread reflects risk and market power.

The adjustment in the loan market takes place through the balance sheets of the household, financial and non-financial sectors.

The bond market operates similarly. However, in this case the changes in demand are on the financial and foreign sectors sides. An increase in the supply of bonds requires higher bond yield to encourage agents to purchase bonds.

#### *Income of institutions*

Every institution receives factor income ( $YIF$ ), dividends ( $DVD$ ), interest income ( $INT$ ), other income ( $OI$ ) and social contributions ( $SCOC$ ). The government also receives tax revenue.

$$PRC_t \cdot YI_t^i = \sum_f YIF_t^{i,f} + DVD_t^i + INT_t^i + OI_t^i + SCOC_t^i \quad (38)$$

In the case of government, income is equal to

$$PRC_t \cdot YI_t^{gov} = YIO_t + ts_t \cdot PQ_t \cdot QQ_t + ta_t \cdot PA_t \cdot QA_t + tm_t \cdot pwm_t \cdot EXR_t \cdot QM_t + \sum_{insd} td_t \cdot PRC_t \cdot YI_t^{insd} \quad (39)$$

where  $YIO_t$  is explained by equation 38; government generates tax revenue from sales taxes, activity taxes, import tariffs and direct taxes on income such as personal income tax and corporate income tax.

These identities reflect the structure of our financial SAMs, which mirror the production and distribution accounts published by the Central Bank.

The factor income received by each domestic agent is defined as:

$$YIF_t^{i,f} = shr^i \cdot (YF_t^f - EXR_t \cdot yfrow^f) \quad (40)$$

We assume that in each period the share of labour and capital income that goes to each domestic agent is fixed. We also assume that the factor income paid to the rest of the world ( $yflow^f$ ) is exogenous and fixed in foreign currency units.  $YF_t^f$  is simply the product of the factor return  $WF$  and the quantity of factors employed  $QF$ . All agents except the foreign sector receive capital returns but it is only the foreign sector and households that receive wages.

The dividend income is divided according to the share of equities that each agent holds. For example, the more equities households hold, the more dividend income they will receive. There are three sources of dividend income. These are the financial and non-financial sectors and the rest of the world. The dividend income from the foreign sector is exogenous and fixed in foreign currency units. The dividend payments by the financial and non-financial sectors are determined by the following equation:

$$DVDP_t^{iii} = (1 - td_t^{iii}) \cdot PRC_t \cdot YI_t^{iii} - SC_t^{iii} - OIP_t^{iii} - IEXP_t^{iii} - SAV_t^{iii} \quad (41)$$

Dividends paid by the financial and non-financial sectors (the set *iii*) are a function of after-tax income, social contributions, interest expenditure and other expenditure paid as well as the savings decisions of the two sectors. It is important to note that dividend payments can be negative, which is equivalent to the holders of equity injecting money into the two sectors. Higher savings reflect higher retained earnings.

Interest income is divided similarly to dividend income. All the interest payments go into a pool, which is divided according to the holding of interest bearing assets by the various agents. The interest paid by each agent is defined in the two equations below:

$$IEXP_t^i = r_{t-1}^l \cdot SL_{t-1}^{i,l} + r_{t-1}^{cd} \cdot SL_{t-1}^{i,cd} + IEXPB_t^i \quad (42)$$

$$IEXPB_t^i = r_{t-1}^b \cdot dl_{t-1}^{i,b} + IEXPB_{t-1}^i \quad (43)$$

Changes to the interest rates of loans and cash and deposits apply to the entire liability stock, whereas for bonds the change applies only to debt issued in the same period.  $IEXPB_t^i$  is the interest income generated on bonds.

The other income received by agents is a fixed share of the pool of other payments. We assume that the share does not change. For domestic agents, we assume that the other payments are fixed share of GDP in the previous period, while for the foreign sector they are fixed in foreign currency units and fluctuate with changes in the exchange rate. The social contribution income is modelled the same way.

#### *System constraints*

Our system is stock and flow consistent. The model system constraints apply to both the real and the financial sides. The real side constraints are similar to other Computable General Equilibrium models such as the model developed by Devarajan and Go (1998). The income and expenditure must be equal. In addition to the real balances, in a financial Social Accounting Matrix (SAM), we have to add the financial balances. The financial SAM enforces flow consistency across real and financial flows. The sources of funds must equal the uses of funds for every institution and the total change (across all institutions) in the holding of a financial instrument on the asset side must be equal to the change on the liability side.

The first real economy constraint is that the total supply must be equal to the total demand in the economy.

$$QQ_t = QINTA_t + QH_t + QG_t + \sum_i INV_t^i + inv \quad (44)$$

The term *inv* represents the change in inventories, which are exogenous in our framework. The supply in the economy is given by imports and the domestically produced good supplied to the local market.

In our framework, the demand for factors of production (eq 45) is a function of  $y_t^{gap}$  (eq 46), which is a proxy for the output gap. It captures deviations from full employment levels driven by the economic cycle. The  $y_t^{gap}$  can vary between 0.95 and 1.05, indicating that demand for labour and capital can be slightly below or above the supply (i.e. negative or positive output gap). While this is a hard constraint, the structure of the model does not allow for it become binding.<sup>21</sup> The

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<sup>21</sup> During the calibration process, the imposition of the constraint led to an effective way of ensuring that the system properties of never generating output gaps larger than 5 per cent are achieved. The initial imposition of the constraint led to the model generating infeasible solutions. By changing key coefficients (in equations 25, 34, 46 and the demands for loans and cash and deposits), the model

response of equations 25 (Reserve Ratio), 34 (Taylor rule), 46 (Capacity Utilisation) and the responses in the demand for goods, services and financial assets and liabilities ensure that deviations from potential growth are rapidly corrected.

$$QF_t^f = y_t^{gap,f} \cdot QFS_t^f \quad (45)$$

The proxy variable is a function of the real loan rate and deviations of aggregate demand from its steady state. An increase in the real rate reduces the demand for factors of production (the output gap becomes more negative), whereas aggregate demand growth which exceeds the steady state growth rate increases the demand for factors of production.

$$y_t^{gap,f} = y_{t-1}^{gap,f} - \alpha_1^{gap,f} \cdot (r_{t-1}^l - \pi_{t-1}) + \alpha_2^{gap,f} (\Delta AD_{t-1} - \Delta ad) \quad (46)$$

The elasticities  $\alpha_1^{gap,f}$  and  $\alpha_2^{gap,f}$  reflects the responsiveness of the proxy measure to the change in the real rate and the deviation of aggregate demand from its steady state growth level. The coefficients for labour are larger, indicating that labour changes are more sensitive to changes in aggregate demand and the interest rate cycle. The specification also implies that factor returns adjust. A fall in factor costs indicates that either the supply is rising faster than the demand or  $y_t^{gap}$  is falling.

The next constraint is the current account balance constraint, which ensures that the country's spending of foreign currency is equal to its inflows. It is expressed in foreign currency units:

$$SAVF_t = pwm_t \cdot QM_t - pwe_t \cdot QE_t - TRANSF_t \quad (47)$$

where  $TRANSF_t = nyif + NDVD_t + NOI_t + NINT_t$

Foreign savings ( $SAVF$ ) are equal to the trade balance minus the balance on the income portion ( $TRANSF$ ) of the current account. The latter is a function of net factor payments ( $nyif$ ), which are fixed and exogenous, net dividend receipts ( $NDVD$ ), net interest receipts ( $NINT$ ) and net other income ( $NOI$ ). We assume that foreign savings are fixed, which implies that the current account deficit is fixed. The exchange rate adjusts to ensure that the equilibrium is maintained. This is our closure with respect to the external balances. For example, an increase in dividend

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property to oscillate within a range of negative output gap of 5 per cent to positive output gap of 5 per cent was achieved. The approach to calibrating all parameters is explained in section 3.4.



outflows, holding foreign savings fixed, requires the exchange rate to depreciate, reducing the outflows in foreign currency units and imports, while increasing exports.

The last real economy constraint is the savings-investment balance, which ensures that total savings in the economy are equal to total investment. The adjustment, as indicated earlier, takes place through the savings rate of the financial and non-financial sectors.

$$\sum_i SAV_i^i + EXR_t \cdot SAVF_t = \sum_i PRC_t \cdot INV_i^i + inv \quad (48)$$

There are two financial constraints. The first one is that the sources of funds must be equal to the uses of funds for every institution. This constraint is enforced through our approach of calculating gross financial wealth available for investment in every period and its allocation to various assets. The second constraint is that the stock of liabilities is equal to the stock of financial assets for every financial instrument.

$$\sum_i SA_t^{f,i,i} = \sum_i SL_t^{f,i,i} \quad (49)$$

For loans and bonds, this is achieved through the loan and bond rates respectively. For equities and cash and deposits, the adjustment takes place through the non-financial equity liabilities and the cash and deposit liability of the financial sector. In the case of other assets, the adjustment takes place through the other liabilities of the foreign sector.

#### *Consumers*

The entire system of equations is solved maximising the household utility function:

$$U_0 = \sum_{t=0}^{10} \beta^t \text{Log}(QH_t) \quad (50)$$

where  $\beta = (1 + \rho)^{-1}$ ,  $\rho$  is a positive parameter and  $\beta$  is the implied discount factor. In every period the household solves an intertemporal optimisation problem to determine the current value of its consumption and savings, based on the real financial wealth that it wants to achieve in 10 periods, plus the model constraints determined by the other equations in the system. The choice of a finite period reflects the permanent income hypothesis (Friedman 1957). Households base their

consumption not on their current income, but the income they generate over a period of time. The target real net wealth is set as follows:

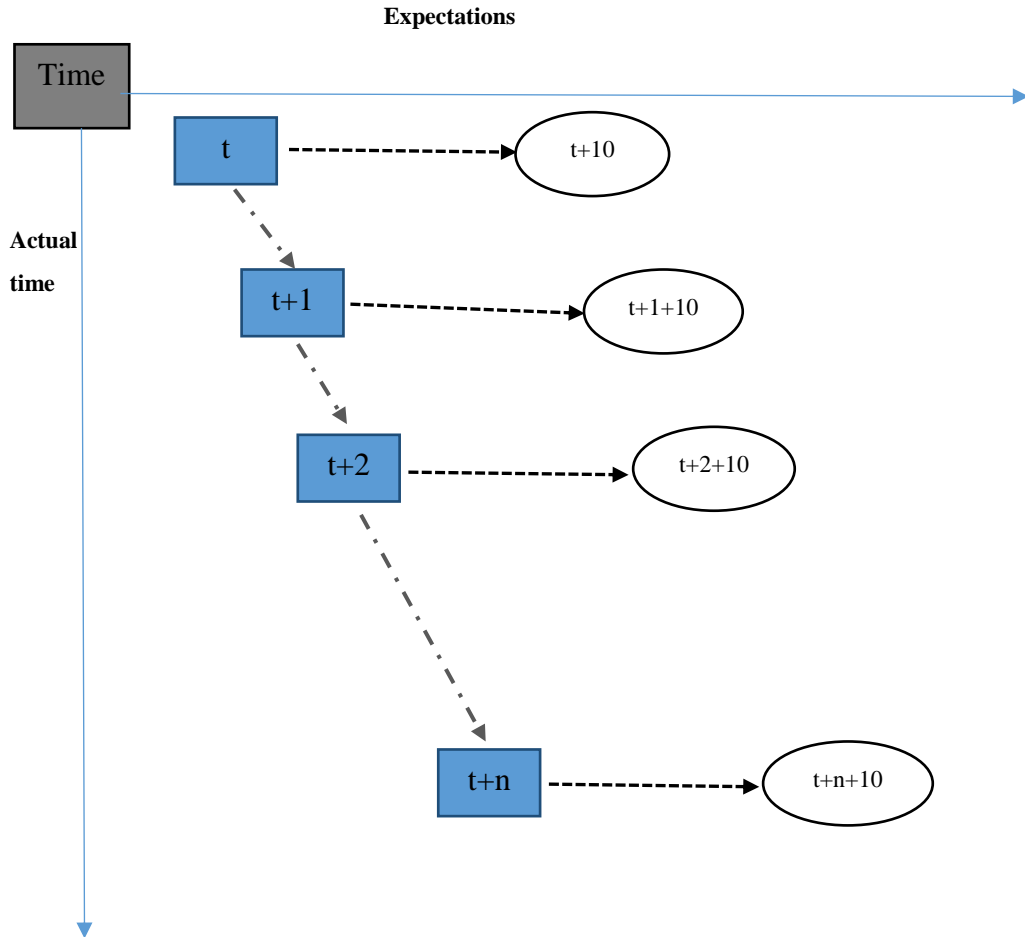
$$FW_{t,t+10}^H = FW_{t-1}^H \cdot (1 + \mu^{fw})^{10} \quad (51)$$

The target wealth in the current period is based on the solution from the previous period adjusted for a real return  $\mu^{fw}$ .

#### *Dynamics*

Figure 3.3 provides a diagrammatic representation of the household optimisation solution. The boxes represent the optimal path. In principle, the model could run forever; however, we limit the solution to 22 periods.

**Figure 3.3: The household optimisation path**



The dynamics of the model presented here differ from standard recursive CGE models. On the one side, the intertemporal optimisation of the household requires that the model system is solved simultaneously over a finite period of time. At the same time, once a solution is found, the variables in the current period become fixed

state variables for the intertemporal optimisation in the next period. The diagram below explains the solution process. At period  $t$ , the representative household decides on consumption and savings based on its expectations about the economy over the next 10 periods and a level of wealth that it wants to achieve. The target is based on an exogenous growth rate, which indicates the real wealth that the representative household would like to achieve in the future given its current level of wealth. For simplicity, the wealth target assumption is adopted in the tradition of Pigou's real wealth effect (Patinkin 1948; Tobin 1975). Once a solution is found for period  $t$ , the household solves for period  $t+1$ . The solution values for period  $t$  are used as starting values for period  $t+1$ .<sup>22</sup>

Our assumptions about expectations are different from mainstream DSGE models. The household has model-consistent expectations (similar to DSGE models) within each period. It has good understanding of the structure of the economy and uses the rules in the model to form expectations. However, the ability of households to foresee the future is limited to ten periods (two and a half years)<sup>23</sup> and the formation of expectations can vary between periods. New formation of expectations can be introduced, for example, by shortening or increasing the optimisation period, changing the value of coefficients or the structure of equations between periods represented by the blue blocks in Figure 3.3. As the household solves for each period, new information about the economy becomes available, which is incorporated into the next period's optimisation. Our expectation formation resembles the process identified by Roos and Luhan (2013). They find that households have bounded rationality rather than full-rationality.<sup>24</sup> A significant number of households use more sophisticated models of the economy taking additional information into account as it becomes available to form expectations,

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<sup>22</sup> In terms of model dynamics, the solution process is introduced through a loop, which traces the path identified by the blue blocks in Figure 3.3. Once a solution is found for  $t$ , the loop moves to the next period. In each case the solution for the variable represented by the blue block is derived through intertemporal optimisation reflecting the structure of the model economy and the household desire to achieve a certain level of wealth in the future.

<sup>23</sup> The assumption of ten periods reflects the period that monetary shocks take to dissipate in an economy and the inflation expectations period generally being targeted by Central banks. We have assumed that this period also reflects the household expectation horizon.

<sup>24</sup> Hommes (2011) provides a review of the literature on bounded rationality. The theory of bounded rationality originates in the seminal work of Simon (1955).

but they do not have perfect foresight. The presence of only one household in our framework, however, limits our ability to capture heterogeneity of expectations.

The model description above outlined some of the dynamic equations. These include, for example, prices (eq 11), prices expectations (eq 16), financial wealth (eq 22), the Tobin asset demand function (eq 23) and the Taylor rule (eq 34). In addition to these, the capital stock follows the standard approach where capital stock ( $QFS_t^k$ ) in the current period is a function of capital stock in the previous period after depreciation ( $\delta$ ) plus total real investment in the previous period.

$$QFS_t^k = (1 - \delta) \cdot QFS_{t-1}^k + \sum_i INV_{i,t-1} + inv \quad (52)$$

The labour supply ( $QFS_t^l$ ) is simply modelled as growing by an exogenous growth rate  $\rho^{lab}$ .

$$QFS_t^l = (1 + \rho^{lab}) \cdot QFS_{t-1}^l \quad (53)$$

Finally, the household optimisation is assumed to generate a constant savings rate (savings plan) over the 10-quarter optimisation period. This is driven by the equation below, which ensures that the after-tax savings rate in the current period is equal to the rate in the previous period.

$$\frac{SAV_t^H}{(1 - td_t^H) \cdot PRC_t \cdot YI_t^H} = \frac{SAV_{t-1}^H}{(1 - td_{t-1}^H) \cdot PRC_{t-1} \cdot YI_{t-1}^H} \quad (54)$$

The solution process for households is different to conventional models, which use savings to smooth consumption. In our model, wealth accumulation is more important than consumption. Savings-smoothing ensures more stable path for household wealth as well as interest and dividend income.

Demands arise from the household, government, investment and net exports. The growth rate in aggregate demand reflects: the household's decision to accumulate wealth given its total income and performance of financial markets; government's exogenous growth rate in consumption; investment by institutions, which is a function of income, borrowing costs and equity prices (in the case of non-financial firms); and relative export and import prices, domestic demand and production, which determine net exports. Growth rate in aggregate demand, which exceeds the

steady state  $\Delta ad$  pushes  $y_t^{gap,f}$ , which leads to higher borrowing costs in the economy and starts a process of re-equilibrating.

### 3.3 Data

In this section, we present the data used to calibrate the model. We construct financial macro Social Accounting Matrices (SAMs) for the South African economy over the period 2001 to 2012. Our approach follows the method outlined by Emini and Fofack (2003) and Hubic (2012). Capital and financial blocks are added to the standard SAM. These reflect the transactions that take place in the financial sector: the incurrence of liabilities and the accumulation of assets by institutions. The changes in liabilities and assets for a particular institution also reflect how the savings-investment balance (capital account) is financed.

**Table 3.1: Aggregation of financial instruments**

<b>Cash and Deposits</b>	<b>Equities</b>	<b>Loans</b>
Cash and demand monetary deposits; Short/medium-term monetary deposits; Long-term monetary deposits; Deposits with other financial institutions ; Deposits with other institutions;	Securities of public enterprises; Ordinary shares; Interest in retirement and life funds; Other loan stock and preference shares;	Bank loans and advances; Trade credit and short-term loans; Long-term loans; Mortgage loans;
<b>Bonds</b>	<b>Other</b>	
Treasury bills; Short-term government bonds; Long-term government bonds; Non-marketable government bonds; Securities of local governments;	Gold and other foreign reserves; Other bills; Foreign branch/head office balances; Amounts receivable/payable Other assets/liabilities; Balancing item;	

The financial block requires flow of funds data, which is produced by the South African Reserve Bank and is available from 1970. The South African data provides for 11 institutional units and 23 financial instruments. These are aggregated into six institutions and five financial instruments. The aggregation is driven by: availability of production and distribution accounts, which are available on a more aggregate level; other data limitations, which we outline below; and the need to

reduce the computational and behavioural complexity of the model. After the aggregation, the financial instruments are cash and deposits, equities, bonds, loans and other, while the institutions are the representative household, financial sector, Reserve Bank, non-financial enterprises, government and the foreign sector.

The aggregation of institutions does not lead to consolidation of flows – i.e flows between institutions which are part of the same category are not netted out. This reflects the absence of whom-to-whom accounts in South Africa as well as the presence of the same practice in the production, accumulation and distribution accounts.

Table 3.1 and Table 3.2 summarise the aggregation. The financial macro SAMs impose flow consistency on the model.

**Table 3.2: Institutional aggregation**

<b>Foreign Sector</b>	<b>SARB</b>	<b>Financial Sector</b>
Foreign Sector;	Monetary Authority;	Other monetary institutions; Public Investment Corporation; Insurers and Retirement Funds; Other Financial Institutions
<b>Government</b>	<b>Non-financial Enterprises</b>	<b>Households</b>
Central and Provincial Government; Local Government;	Public Sector; Private Sector;	Households;

The stock consistency requires the construction of balance sheets which are consistent with the flow of funds data. While the Reserve Bank provides balance sheet information for some institutions, it is impossible to link the balance sheet information to the flow of funds data as there is no consistency in terms of the financial instruments listed in the different tables. The quality of balance sheet information is a significant limitation to the framework that we present. This is a global problem which is highlighted by the G20 Data Gap Initiative.<sup>25</sup>

We provide a short overview on our approach to constructing financial balance sheets. The building of balance sheets for institutions relies on flow of funds data from 1970 onwards and the balance sheet information available in the *Quarterly*

<sup>25</sup> For more information of the G20 Data Gap Initiative see <http://www.fsb.org/2016/09/second-phase-of-the-g20-data-gaps-initiative-dgi-2-first-progress-report/>

*Bulletin* published by the South African Reserve Bank. It is important to note that our institutional balance sheets deal only with financial instruments as consistent data on ownership of non-financial assets and liabilities is not available. Thus, our balance sheets are partial but consistent when it comes to financial assets and liabilities.

The general approach followed is to add up the data from the flow of funds over the period 1970 to 2001. This calculates the stock of assets and liabilities accumulated over the period. While the values are smaller than the actual stock of assets and liabilities, they will be a good approximation as the values over the period 1970 to 2001 should exceed by far the stock values prior to 1970. They should constitute most assets and liabilities accumulated. The approach is similar to the perpetual inventory method and resembles the method employed by Aron and Muellbauer (2006) and Aron, Muellbauer, and Prinsloo (2006). They estimate household wealth and balance sheets for South Africa.

Our second step is to compare the values of stocks generated in the first step against the balance sheet information presented in the *Quarterly Bulletin* for some of the institutions. Generally, the approach using the flow of funds data generates stock variables, which are in line with the *Quarterly Bulletin* data for deposits and some of the loan variables, but significantly different for equities and bonds. This is due to the flow of funds data recording some transactions at book value and some at market value, creating a discrepancy between the balance sheets generated in the first step and the balance sheets presented in *Quarterly Bulletin*.

A key challenge with the flow of funds data is that it does not distinguish between changes due to changes in the holding of units, changes due to changes in the price of the financial instrument and other changes. The second challenge is that the financial instruments in the flow of funds data are not directly comparable to the financial instruments used in the different balance sheets presented in the *Quarterly Bulletin*. More importantly, balance sheets are not produced for all institutions and there is no consistency in terms of the representation of financial instruments. This requires that we create our own consistent financial balance sheets.

In the next step, the data is updated with the balance sheet information from the *Quarterly Bulletin* where significant differences exist and it is reasonable to assume

that the differences are primarily because of uncaptured capital gain effects. The flow of funds data is applied to the updated balance sheet information for 2001 to generate balance sheet information for the period 2002 to 2012. This approach guarantees that the balance sheet data generated over the period from 2002 to 2012 links to the set of financial SAMs through the changes in assets and liabilities. The approach ensures consistency in stocks and flows. The data is aggregated following the matching in Table 3.1 and Table 3.2. The stock variables are not consolidated during the aggregation process – *i.e.* no netting out takes place. This is driven again by the absence of whom-to-whom accounts and the use of the same practice in the production, accumulation and distribution accounts.

The balance sheet data from the *Quarterly Bulletin* is also compared to the balance sheets calculated using the flow of funds for 2012. Again, there are some discrepancies for some financial instruments, particularly equities. Despite these differences, no further changes are made to the balance sheet data calculated using the flow of funds data as this requires changes to the underlying net purchases of financial assets and liabilities. This will break the link with the financial SAMs and the savings and investment data and create flow and stock inconsistencies in our data set.

The absence of separate price and quantity effects in the flow of funds data hinders the modelling of prices for financial instruments, particularly the prices of bonds and equities. We model only the equity price, which is based on the Johannesburg Stock Exchange all share index. The adjustment to the equity stocks follows the same approach as outlined by Aron and Muellbauer (2006). This adjustment leads to equity stock values which are more in line with the balance sheet information from the *Quarterly Bulletin*.

The two categories *Amounts receivable/payable* and *Other assets/liabilities* are grouped in a category labelled *Other*. These two items tend to generate large negative flows for some institutions, which persist over a long period of time. The behaviour of these flows reflects the current challenges with the flow of funds data, which are expected to be resolved as part of the G-20 Data Gap Initiative. We have chosen to treat the *other* category as a residual item, which is important to balance



the stocks and the financial macro SAMs, but it has no behavioural function in our model.

Table 3.3 and Table 3.4 below provide a summary of the balance sheets generated through the process described above as well the assets and liabilities owned by the various institutions. While our aim is not to provide a detailed assessment of the balance sheet information, we need to highlight some trends.<sup>26</sup>

The largest compositional changes are experienced by the Reserve Bank as well the financial, non-financial and foreign sectors. For the Reserve Bank, the share of loans as part of assets and liabilities has declined while the share of cash and deposit liabilities has increased over the period 2001 to 2012. In the case of the financial and non-financial sector, there has been a notable increase in holding of equities as percentage of total assets and liabilities. This reflects price effects but also greater issuance of shares. The share of loans as assets on the balance sheet of non-financial institutions has been halved. The share of loans on the balance sheet of financial institutions is small – around 20 per cent. This reflects our aggregation approach, which groups other monetary institutions with all other financial institutions, thus diluting the share of total loans in overall assets. The share of equities has significantly increased in the foreign portfolio of residents. This reflects the relaxation of exchange controls, which has led to the increased purchases of equities by South African residents.

Looking at the specific financial instruments in Table 3.4, the value of equities has seen the strongest growth over the period largely driven by a significant increase in the price.

The financial sector has the largest share of equities on the asset and liability sides compared to other institutions. On the liability side, the share reflects our classification approach. Household *interests in retirement and life funds* were classified as part of the financial sector equity liability. This also explains the large equity ownership share of households. Household financial wealth is mainly in the form of *interests in retirement and life funds*, which accounted for almost 90 per cent of the total household financial assets in 2012. This reflects the South African

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<sup>26</sup> For more information on South Africa's flow of funds data see Monyela and Madonsela (2015).

pension system, where individuals' contributions to retirement annuities and pension funds during their working life are used to purchase pension upon retirement.

The financial sector, as expected, holds almost all the cash and deposits in the economy on the liability side (92 per cent in 2012), in line with its intermediation function. The sector also holds a large share of the cash and deposits assets, followed by the non-financial sector and households.

The largest holders of government bonds are the financial sector with close to 77 per cent of all bonds, a share which has been stable over the period 2001 to 2012, and the foreign sector, whose share has doubled over the period. The foreign sector's importance as funder to the domestic economy has increased significantly with the asset side increasing by more than 700 per cent. This reflects relaxation of capital controls, high global liquidity and low domestic savings. The disproportional increase in the liability side implies that depending on the rates of return on the asset and liability side and the exchange rate, the net dividend and interest income outflows are likely to remain large and contribute negatively to the current account.

Loans are mainly provided by financial institutions, but also by non-financial enterprises and the foreign sector. Non-financial enterprises provide mainly trade loans and are also a large recipient of loans, along with households. For households, close of 50 per cent of their loan liability is in the form of *mortgages*, while for non-financial institution the loan category is dominated by *bank loans and advances*.

The *Other* category is negative for some institutions. This reflects the challenges with the flow of funds data, which were explained earlier. The *Other* category is used as an exogenous item. It is modelled endogenously only for the Reserve Bank and the Foreign Sector. Foreign reserves of the Reserve Bank are classified in the *Other* category. They are an asset for the Bank and a liability for the foreign sector. We described our modelling approach of the foreign currency reserves in the previous section.

The data used for the econometric calibration of some of the coefficients is sourced from the Reserve Bank and it is also published in the *Quarterly Bulletin*. This is data on interest rates, growth rates and price indices.

**Table 3.3: Composition of partial financial balance sheets of institutions**

<i>year 2001 (% of total)</i>	Reserve Bank		Financial institutions		Governments		Non-financial institutions		Households		Rest of the World	
	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities
Cash and Deposits	0,1	43,7	14,0	36,5	48,9	0,0	34,7	1,2	26,3	0,1	10,5	13,7
Bonds	6,2	0,0	9,9	0,0	2,3	75,8	5,9	0,0	0,1	0,0	6,7	0,3
Equities	1,6	6,9	37,7	51,7	4,2	0,3	12,7	72,0	78,5	0,0	74,5	41,4
Loans	19,1	53,1	26,8	4,1	35,2	13,7	39,3	30,6	1,8	83,1	11,9	28,7
Other	73,0	-3,7	11,6	7,7	9,4	10,1	7,5	-3,8	-6,7	16,8	-3,6	15,8
<b>Total (R million)</b>	<b>148 908</b>	<b>110 755</b>	<b>2 867 644</b>	<b>2 866 737</b>	<b>108 290</b>	<b>516 141</b>	<b>1 071 964</b>	<b>1 083 222</b>	<b>1 170 652</b>	<b>718 843</b>	<b>468 229</b>	<b>539 989</b>
<i>year 2012 (% of total)</i>												
Cash and Deposits	4,2	75,8	16,1	29,4	99,9	0,0	31,4	0,1	13,7	0,0	2,4	0,2
Bonds	1,2	0,0	6,9	0,0	0,5	70,2	0,9	0,0	0,5	0,0	5,4	0,0
Equities	2,0	5,0	52,0	62,7	10,2	0,7	30,3	83,4	87,6	0,0	70,6	74,7
Loans	5,5	32,5	21,3	3,8	44,8	8,0	19,7	22,1	0,5	77,8	13,9	10,0
Other	87,1	-13,3	3,7	4,1	-55,4	21,1	17,6	-5,6	-2,2	22,2	7,7	15,2
<b>Total (R million)</b>	<b>502 472</b>	<b>462 685</b>	<b>13 296 904</b>	<b>14 603 042</b>	<b>504 817</b>	<b>1 698 866</b>	<b>3 044 478</b>	<b>6 879 223</b>	<b>6 858 709</b>	<b>2 141 453</b>	<b>3 862 913</b>	<b>2 285 463</b>
% change	237,4	317,8	363,7	409,4	366,2	229,1	184,0	535,1	485,9	197,9	725,0	323,2

Source: Own calculation based on South African Reserve Bank data

**Table 3.4: Ownership of financial instruments**

year 2001 (% of total)	Equities		Cash and Deposits		Loans		Bonds		Other	
	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities
Reserve Bank	0,1	0,3	0,0	6,3	2,1	4,4	2,3	0,0	25,0	-1,0
Financial Institutions	43,4	59,4	34,0	88,4	57,6	8,8	72,6	0,0	76,3	51,0
Government	0,2	0,1	4,5	0,0	2,9	5,3	0,6	99,6	2,3	12,0
Non-financial institutions	5,5	31,3	31,4	1,1	31,6	24,9	16,1	0,0	18,4	-9,5
Households	36,9	0,0	26,0	0,1	1,6	44,9	0,4	0,0	-18,1	27,7
Rest of the World	14,0	9,0	4,1	6,3	4,2	11,6	8,0	0,4	-3,8	19,6
<b>Total (R million)</b>	<b>2 493 277</b>	<b>2 493 277</b>	<b>1 183 143</b>	<b>1 183 143</b>	<b>1 331 370</b>	<b>1 331 370</b>	<b>392 842</b>	<b>392 842</b>	<b>435 055</b>	<b>435 055</b>
year 2012 (% of total)										
Reserve Bank	0,1	0,1	0,5	7,5	0,6	3,5	0,5	0,0	22,4	-4,6
Financial Institutions	41,5	55,0	46,1	92,2	66,5	13,0	76,9	0,0	37,0	45,1
Government	0,3	0,1	10,8	0,0	5,3	3,2	0,2	100,0	-20,9	26,9
Non-financial institutions	5,6	34,5	20,5	0,2	14,1	35,7	2,2	0,0	40,2	-28,9
Households	36,1	0,0	20,1	0,0	0,7	39,2	2,8	0,0	-11,4	35,6
Rest of the World	16,4	10,3	2,0	0,1	12,6	5,3	17,4	0,0	22,4	26,0
<b>Total (R million)</b>	<b>16 629 425</b>	<b>16 629 425</b>	<b>4 659 809</b>	<b>4 659 809</b>	<b>4 253 065</b>	<b>4 253 065</b>	<b>1 192 420</b>	<b>1 192 420</b>	<b>1 335 574</b>	<b>1 335 574</b>
% change	567,0	567,0	293,9	293,9	219,5	219,5	203,5	203,5	207,0	207,0

Source: Own calculation based on South African Reserve Bank data

### 3.4 Calibration

In this section, we explain our calibration strategy and we present the value of the coefficients.

The data used is a series of financial Social Accounting Matrices over the period 2002 to 2012 and National Accounts data for South Africa. The data sources are discussed in the previous section.

The derivation of the scale and share parameters for the Armington and CET functions follows the standard approach in CGE models as described by Condon, Dahl, and Devarajan (1987). We use 2002 as the base year, but we also compare the values of coefficients and ratios using later years. There are several coefficients, which are calibrated directly from the base year macro SAM. These include tax rates, various share parameters and the relationship between intermediate inputs and value added. Prices such as PQ, PEQ and the exchange rate are set to one in the first quarter of 2002. The financial balance sheets for 2002 are used with the base year SAM to generate coefficients which link economic behaviour to the holding of stocks. For example, these include the parameters  $\alpha^{ins,l}$  (in the loan demand function) and  $\alpha^{il,cd}$  (in the cash and deposit function). The values of all coefficients are listed below in Table 3.5.

The substitution elasticities are based on the recent analysis by Kreuser, Burger, and Rankin (2015) and Saikkonen (2015). The two studies provide substitution elasticities for several sectors. Our factor substitution elasticity is in the lower range

of those provided by Kreuser, Burger, and Rankin (2015), in line with the short-term nature of our framework. Our Armington elasticity is 0.5, while our CET elasticity is 0.2. Saikkonen (2015) finds that the Armington elasticities vary between 0.39 to 1.38. We assume a low CET elasticity consistent with available evidence on limited export response to exchange rate shifts.

A key challenge with our model is that many of the coefficients related to financial behaviour are not available for South Africa. This is a large area for future research. Our strategy here is to utilise coefficients generated by other studies, bearing in mind the limitations of this approach, or to get some sense of the relationship through simple econometric estimates, which are further calibrated in the model to generate a consistent baseline.

The coefficients for the asset demand function are based on those used by Godley (1996) and Godley and Lavoie (2007). The coefficients reflect the stronger response of equity and bonds to changes in relative prices. The  $\lambda_{i0}$  coefficients, which reflect the initial shares, are calibrated using our balance sheet data for 2002.

An econometric approach is used to generate priors for several elasticities. These include the elasticities in the equation for the reserve ratio, the elasticities  $\mu^l$  and  $\mu^{cd}$  in the demand for loans and cash and deposits equation as well as  $\alpha_1^{gap,f}$  and  $\alpha_2^{gap,f}$  in the equation defining the output gap specification. The priors are manually adjusted so that the model generates a consistent baseline.

Steady state growth rates reflect average values for the period from 2002 to 2012 using quarterly annualised data. The growth of the labour force represents the average quarterly labour force growth in South Africa. Growth in government consumption expenditure and total factor productivity is calibrated similarly. The inflation target is assumed to be six per cent in line with the upper bound of the inflation target and the level of inflation expectations by trade unions and businesses, which appear to be stuck at that level.

Finally, several exogenous variables are fixed to the baseline year. These include foreign savings, income generated by non-residents, foreign income generated by residents, interest income on the liabilities of the foreign sector, the bond and cash and deposit liabilities of the foreign sector as well as foreign currency prices of

South African exports and imports. Exogenising these variables and fixing them to the base year values reduces the complexity of the model and eliminates the shocks that may come from their changing values.

**Table 3.5: Exogenous parameters**

$\alpha_1^{gap,l}$	Responsiveness of the demand for factors of production to real loan rates	0.45	$\mu^l$	Responsiveness of the demand for loans to changes in the real borrowing costs	-5
$\alpha_1^{gap,k}$		0.40			
$\alpha_2^{gap,l}$	Responsiveness of the demand for factors of production to aggregate demand	0.35	$\mu_1^{peq}$	Responsiveness of equity prices to inflation expectations	0.55
$\alpha_2^{gap,k}$		0.3			
$\alpha^{mgov,cd}$	Demand for cash and deposits as share of income – government sector	0.13	$\mu_2^{peq}$	Responsiveness of equity prices to money supply	0.2
$\alpha^{mhh,cd}$	Demand for cash and deposits as share of income – household	0.34	$\mu_3^{peq}$	Responsiveness of equity prices to economic activity	0.33
$\alpha^{nfin,cd}$	Demand for cash and deposits as share of income – nonfinancial sector	1.16	$\mu_2^{r,cd}$	Coefficient in the cash and deposit rate equation	0.6
$\alpha^{cb,l}$	Demand for loans as share of income - Reserve Bank	12.7	$\lambda_{b,0}^{fin}$	Tobin demand coefficient showing the steady state share of bonds in total wealth ( <i>fin</i> -financial sector, <i>mrow</i> -foreign sector)	0.22
			$\lambda_{b,0}^{mrow}$		0.18
$\alpha^{fin,l}$	Demand for loans as share of income - financial sector	0.31	$\lambda_{eq,0}^{fin}$	Tobin demand coefficient showing the steady state share of equities in total wealth	0.52
			$\lambda_{eq,0}^{mrow}$		0.73
$\alpha^{mgov,l}$	Demand for loans as share of income - government sector	0.25	$\lambda_{cd,0}^{fin}$	Tobin demand coefficient showing the steady state share of cash and deposits in total wealth	0.26
			$\lambda_{cd,0}^{mrow}$		0.1
$\alpha^{mhh,l}$	Demand for loans as share of income - household sector	0.61	$\lambda_{b,1}^{fin}$	Tobin demand coefficient - responsiveness of bond to changes in the bond return	1.99
			$\lambda_{b,1}^{mrow}$		1.99

$\alpha^{mrow,l}$	Demand for loans as share of GDP -foreign sector	0.12	$\lambda_{b,2}^{fin}$ $\lambda_{b,2}^{mrow}$	Tobin demand coefficient - responsiveness of bond to changes in the equity return	-1.6 -1.6
$\alpha^{nfin,l}$	Demand for loans as share of income -non-financial sector	1.26	$\lambda_{b,3}^{fin}$ $\lambda_{b,3}^{mrow}$	Tobin demand coefficient - responsiveness of bond to changes in the cash and deposit return	-0.2 -0.2
$\alpha^p$	Production function shift parameter (base year)	0.84	$\lambda_{b,4}^{fin}$ $\lambda_{b,4}^{mrow}$	Tobin demand coefficient - responsiveness of bond to changes in transactional demand for money	0 0
$\alpha^m$	Import function shift parameter	1.32	$\lambda_{eq,1}^{fin}$ $\lambda_{eq,1}^{mrow}$	Tobin demand coefficient - responsiveness of equity to changes in the bond return	-1.3 -1.3
$\alpha^t$	Export function shift parameter	5.55	$\lambda_{eq,2}^{fin}$ $\lambda_{eq,2}^{mrow}$	Tobin demand coefficient - responsiveness of equity to changes in the equity return	1.6 1.6
$\beta^{repo}$	Responsiveness of the financial sector reserve ratio to changes in the repo rate	15.3	$\lambda_{eq,3}^{fin}$ $\lambda_{eq,3}^{mrow}$	Tobin demand coefficient - responsiveness of equity to changes in the cash and deposit return	-0.6 -0.6
$\beta_1^{repo}$	Responsiveness of the supply of loans to changes in the repo rate	-0.7	$\lambda_{eq,4}^{fin}$ $\lambda_{eq,4}^{mrow}$	Tobin demand coefficient - responsiveness of equity to changes in transactional demand for money	- 0.001 - 0.001
$\beta_2^{repo}$	Taylor rule coefficient on inflation	2.0	$\lambda_{cd,1}^{fin}$ $\lambda_{cd,1}^{mrow}$	Tobin demand coefficient - responsiveness of cash and deposit to changes in the bond return	-0.66 -0.66
$\beta_3^{repo}$	Taylor rule coefficient on the output gap	0.3	$\lambda_{cd,2}^{fin}$ $\lambda_{cd,2}^{mrow}$	Tobin demand coefficient - responsiveness of cash and deposit to changes in the equity return	-0.04 -0.04

$\beta^{sa}$	Responsiveness of the financial sector reserve ratio to changes in the growth rate of financial assets	-0.1	$\lambda_{cd,3}^{fin}$ $\lambda_{cd,3}^{mrow}$	Tobin demand coefficient - responsiveness of cash and deposit to changes in the cash and deposit return	0.7 0.7
$\gamma_1^I$	Steady state growth rate of investment	1.04	$\lambda_{cd,4}^{fin}$ $\lambda_{cd,4}^{mrow}$	Tobin demand coefficient - responsiveness of cash and deposit to changes in transactional demand for money	0.001 0.001
$\gamma_2^I$	Responsiveness of investment by the non-financial sector to the Tobin Q term	0.14	$\sigma^{cd}$	Growth of cash and deposit liabilities of the Reserve Bank coefficient	0.027
$\gamma_3^I$	Responsiveness of investment to the real loan rate	-0.9	$grg$	Government consumption growth rate	0.026
$\delta$	Capital depreciation rate	0.5	$inf$	Inflation target (steady state inflation)	0.06
$\delta^p$	Production function share parameter	0.0001	$inta$	Quantity of aggregate intermediate input per output.	0.06
$\delta^q$	Import function share parameter	0.03	$ivat$	Quantity of aggregate output per value added.	0.44
$\delta^t$	Export function share parameter	0.99	$ld^{mgov}$ $ld^{mrow}$ $ld^{nfin}$	Share of wealth provided as loans for the non-financial, government and foreign sectors	0.421 0.065 0.385
$\theta^p$	Responsiveness of price expectation to deviations of expected prices from actual prices in the previous period	0.2	$lmrow$	share of foreign loan and equity liability as percentage of GDP	0.18
$\theta_1^{pq}$	Responsiveness of prices to changes in the output gap	1.5	$mpsbar^{fin}$ $mpsbar^{nfin}$	Steady state savings rate	0.07 0.44
$\theta_2^{pq}$	Responsiveness of prices to changes in import prices	0.5	$oipprm^{fin}$ $oipprm^{mhd}$ $oipprm^{mgov}$ $oipprm^{mrow}$ $oipprm^{nfin}$	Other income paid as share of GDP	0.15 0.04 0.01 0.001 0.01



$\theta^{prce}$	Responsiveness of price expectations to the output gap	0.3	$shifoint^{fin}$	Share of other income received	0.23
			$shifoint^{mhhd}$		0.68
			$shifoint^{mgov}$		0.01
			$shifoint^{mrow}$		0.03
			$shifoint^{nfin}$		0.06
$\rho^{lab}$	Labour force growth	0.01	$shifsoc^{fin}$	Share of social contributions received	0.51
			$shifsoc^{mhhd}$		0.46
			$shifsoc^{mgov}$		0.03
$\rho^p$	Production function substitution elasticity	-1	$soc\_par^{fin}$	Social contributions paid as a share of GDP	0.05
			$soc\_par^{mhhd}$		0.09
			$soc\_par^{mgov}$		0.03
			$soc\_par^{nfin}$		0.004
$\rho^q$	Import function substitution elasticity	1	$ss^{peq}$	Steady state growth in equity prices	0.03
$\rho^{repo}$	Interest rate smoothing coefficient	0.7	$ta$	Activity tax rate	0.009
$\rho^t$	Export function substitution elasticity	11	$td$	Personal direct tax rate	0.009
$\mu^{cd}$	Responsiveness of the demand for cash and deposits to changes in the real return	0.2	$tm$	Import tariff rate	0.027
$\mu^{fw}$	Target real growth rate for household wealth	0.15	$ts$	Sales tax rate	0.038

We move next to discuss the baseline that our model generates.

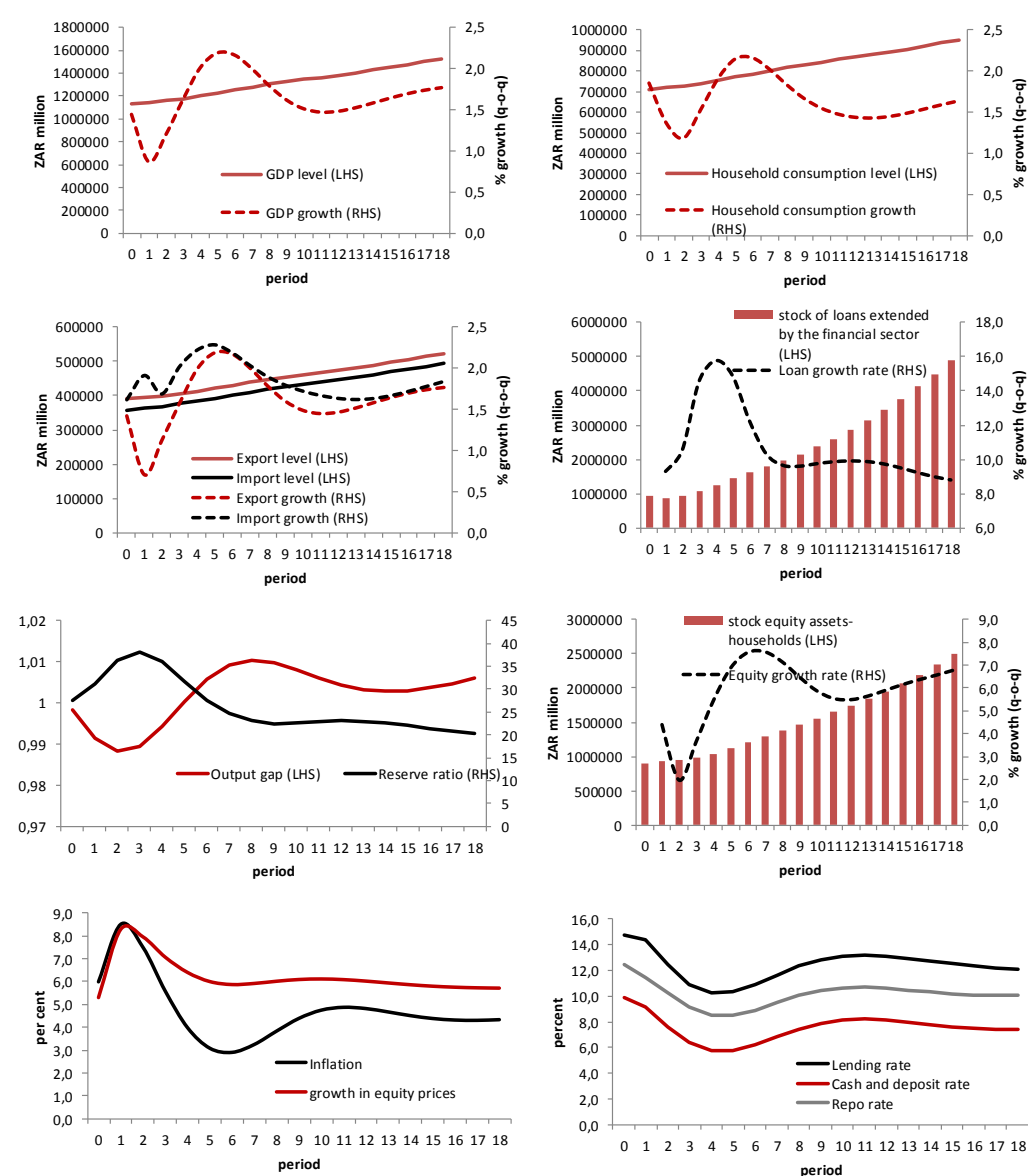
### 3.5 Model Baseline

In Figure 3.4, we present the model-generated baseline, given the choice of values for the coefficients and the set of exogenous variables. The set of initial conditions implies that inflation is rising at the beginning of the baseline period. This causes the repo rate, through the Taylor specification in equation 34, to increase, which in turn affects the lending rate. The higher rates reduce investment and consumption growth, which slows down overall GDP growth. The slowdown in the economy affects the willingness of banks to hold reserves through equation 25. The reserve

ratio initially increases because of the higher repo rate. As the slowdown in economic activity also affects the growth in financial sector asset, this increases the willingness of the sector to hold reserves and puts additional pressure on the reserve ratio. The economic cycle affects probabilities of default, valuations and the perception of risk, which changes the financial sector willingness to hold reserves. The slower pace of economic activity also affects the household creation of equity assets. As the economy slows down and inflationary pressures decrease, the policy rates along with other interest rates start to fall. This provides support to aggregate demand, which accelerates. With greater economic activity, financial activity also accelerates supported by falling willingness of the financial sector to hold reserves and lower lending spreads. Stronger economic activity and growth in money supply support equity growth through equation 17, which supports wealth creation. The growth in loans is in line with GDP growth and falling lending rates. As the loan rate starts to rise, lending slows down and the GDP growth rate moderates.

The quarterly growth rates for aggregate demand variables are on average in the region of 1.5 to 2 per cent higher than the actual growth rates achieved. This reflects that some of the key variables are kept fixed and exogenous. The model achieves stability in the output gap and the reserve ratio to the extent that these as well other variables tend oscillate around a trend path. This represents the steady state of the model. The system is driven by a mechanism that ensure that the model framework always tries to converge to an output gap of zero. It always oscillates around an output gap of zero, similar to real economies. The steady state dynamics are different to current DSGE models, which return to constant steady state growth rates. A shock to the system shifts the cycle. The steady state is achieved through a set of dynamic equations and parameters, which represent steady state growth rates. The key equations are 25 (Reserve Ratio), 34 (Taylor rule) and 46 (Capacity Utilisation). Parameters include the steady state growth rate in aggregate demand  $\Delta ad$ , government consumption expenditure  $grg_t$ , labour force growth rate  $\rho^{lab}$  and the steady state growth in equity prices  $ss^{peq}$ . The sets of equations and parameters ensure that deviation from potential growth are corrected and capital and labour grow at similar rates in the baseline, keeping relative prices constant.

**Figure 3.4: Baseline Path**



Source: Model simulation

In the next three chapters, we illustrate the properties of our model by applying it to our three research questions.

### 3.6 Appendix: Detailed model representation

<i>Indices</i>			
$f$	Factors (labor and capital)	$incb$	Agents ( $infin \subset i$ ) - all sectors except the central bank.
$fi$	Financial instruments (cash and deposits(cd), bonds(b), equities(e), loans (l) and other financial instruments(oa))	$infin$	Agents ( $infin \subset i$ ) - all sectors except the non-financial sector.
$finb$	Financial instruments ( $finb \subset fi$ ) - all except bonds.	$ing$	Agents ( $infin \subset i$ ) - all sectors except government.
$fint$	Financial instruments ( $finb \subset fi$ ) – interest bearing.	$ins$	Agents ( $ins \subset i$ ) - households, financial and non-financial sectors
$i$	Agents (households(h), financial sector(fin), non-financial sector(nfin), government(gov), reserve bank (rb), the rest of the world (row))	$insd$	Agents ( $ins \subset i$ ) - domestic sectors
$ifin$	Agents ( $ifin \subset i$ ) - all sectors except the financial sector.	$it$	Agents ( $it \subset i$ ) - financial and foreign sectors
$ii$	Agents ( $ii \subset i$ ) financial and non-financial sectors	$le$	Financial instruments ( $le \subset fi$ ) - loans and equities
$il$	Agents ( $il \subset i$ ) - households, the non-financial sector and government		
$in$	Agents ( $in \subset i$ ) - the non-financial and foreign sectors and government	$t$	Time periods
<i>Exogenous parameters</i>			
$\alpha_1^{gap}$	Responsiveness of the demand for factors of production to real loan rates	$\mu_3^{peq}$	Responsiveness of equity prices to economic activity
$\alpha_2^{gap}$	Responsiveness of the demand for factors of production to aggregate demand	$\mu^{cd}$	Responsiveness of the demand for cash and deposits to changes in the real return
$\alpha^{i,cd}$	Demand for cash and deposits as share of income	$\lambda_{fi,fi}^{it}$	Coefficients describing the responsiveness of

			the demand for assets for the foreign and financial sectors to changes in asset returns.
$\alpha^{i,l}$	Demand for loans as share of income or GDP for the foreign sector	$\sigma^{cd}$	Growth of cash and deposit liabilities
$\alpha^p$	Production function shift parameter	$dvdcoefpar$	Translation key for dividend income
$\alpha^m$	Import function shift parameter	$grg$	Government consumption growth rate
$\alpha^t$	Export function shift parameter	$inf$	Inflation target (steady state inflation)
$\beta$	Discount factor for household consumption	$inta$	Quantity of aggregate intermediate input per output.
$\beta^{repo}$	Responsiveness of the financial sector reserve ratio to changes in the repo rate	$inv$	Change in inventories
$\beta_1^{repo}$	Responsiveness of the supply of loans to changes in the repo rate	$ivat$	Quantity of aggregate output per value added.
$\beta_2^{repo}$	Taylor rule coefficient on inflation	$ld$	Share of wealth provided as loans for the non-financial, government and foreign sectors
$\beta_3^{repo}$	Taylor rule coefficient on the output gap	$lmrow$	share of foreign loan and equity liability as percentage of GDP
$\beta^{sa}$	Responsiveness of the financial sector reserve ratio to changes in the growth rate of financial assets	$mpsbar$	Steady state savings rate
$\gamma_1^I$	Steady state growth rate of investment	$mps01$	0-1 parameter with 1 for institutions, which marginal propensity to save adjusts
$\gamma_2^I$	Responsiveness of investment by the non-	$n_t^I$	Net change in capital transfers

	financial sector to the Tobin Q term		
$\gamma_3^l$	Responsiveness of investment to the real loan rate	<i>oipprm</i>	Other income paid as share of GDP
$\delta$	Capital depreciation rate	<i>pwe</i>	World export price
$\delta^p$	Production function share parameter	<i>pwm</i>	World import price
$\delta^q$	Import function share parameter	<i>r</i>	Statistical residual
$\delta^t$	Export function share parameter	<i>res</i>	Foreign currency reserves
$\theta^p$	Responsiveness of price expectation to deviations of expected prices from actual prices in the previous period	<i>sa</i>	Stock of other assets excluding reserves
$\theta_1^{pq}$	Responsiveness of prices to changes in the output gap	<i>sl</i>	Stock of equity liabilities of the financial sector other than interests in retirement and life funds
$\theta_2^{pq}$	Responsiveness of prices to changes in import prices	<i>slr</i>	Other than reserve liabilities for the foreign sector
$\theta^{prce}$	Responsiveness of price expectations to the output gap	<i>shifint</i>	Share of interest income
$\rho^{lab}$	Labour force growth	<i>shifoint</i>	Share of other income
$\rho^p$	Production function substitution elasticity	<i>shifsoc</i>	Share of social contributions received
$\rho^q$	Import function substitution elasticity	<i>shr</i>	Share of interest income
$\rho^{repo}$	Interest rate smoothing coefficient	<i>soc_par</i>	Social contributions paid as a share of GDP
$\rho^t$	Export function substitution elasticity	<i>ss^{peq}</i>	Steady state growth in equity prices
$\mu^{cd}$	Responsiveness of the demand for cash and deposits to changes in the real return	<i>ta</i>	Activity tax rate
$\mu^{fw}$	Target real growth rate for household wealth	<i>td</i>	Personal direct tax rate

$\mu^l$	Responsiveness of the demand for loans to changes in the real borrowing costs	$tm$	Import tariff rate
$\mu_1^{peq}$	Responsiveness of equity prices to inflation	$ts$	Sales tax rate
$\mu_2^{peq}$	Responsiveness of equity prices to money supply	$yfrow$	factor income payments to the foreign sector
$\mu_2^{rcd}$	Coefficient in the cash and deposit rate equation	$yfmrow$	factor income received from the foreign sector
<hr/> <i>Endogenous variables</i> <hr/>			
$BSASS$	Stock of assets	$NOI$	Net other income inflows
$BSLIB$	Stock of liabilities	$NINT$	Net interest income inflows
$d_{as\_b}$	Change in the stock of bonds (assets)	$NW$	Net wealth of institutions
$d_{as\_cd}$	Change in the stock of cash and deposits (assets)	$OI$	Other income
$d_{as\_e}$	Change in the stock of equities (assets)	$OIP$	Other payments
$d_{as\_l}$	Change in the stock of loans (assets)	$PA$	Aggregate sector output price
$d_{as\_oa}$	Change in the stock of other (assets)	$PD$	Domestic supply price with margin
$d_{lib\_b}$	Change in the stock of bonds(liabilities)	$PE$	Export price
$d_{lib\_cd}$	Change in the stock of cash and deposits (liabilities)	$PEQ$	Equity price
$d_{lib\_e}$	Change in the stock of equities (liabilities)	$PM$	Import price
$d_{lib\_l}$	Change in the stock of loans (liabilities)	$PQ$	Composite supply price
$d_{lib\_oa}$	Change in the stock of other (liabilities)	$PRC$	Price including sales taxes
$DFRATEB$	Bond rate-adjustment factor	$PRCd$	Inflation
$DFRATECD$	Cash and deposit rate-adjustment factor	$PRCe$	Expected prices
$DFRATEL$	Loan rate-adjustment factor	$PVA$	Composite value-added price
$DVD$	Dividend income	$QA$	Aggregate output quantity

<i>DVDCOEF</i>	Share of dividend income	<i>QD</i>	Domestic supply quantity
<i>DVDFIN</i>	Dividends paid by the financial sector	<i>QE</i>	Export quantity
<i>DVDP</i>	Dividends paid	<i>QF</i>	Factor demand
<i>DVDROW</i>	Dividends paid by the foreign sector	<i>QFS</i>	Factor supply
<i>EXR</i>	Exchange rate	<i>QG</i>	Government consumption quantity
<i>FINT</i>	Interest income paid to the rest of the world	<i>QH</i>	Household consumption quantity
<i>FRATEB</i>	Bond rate	<i>QINTA</i>	Intermediate input
<i>FRATECD</i>	Cash and deposit rate	<i>QM</i>	Import quantity
<i>FRATEL</i>	Loan rate	<i>QQ</i>	Composite supply quantity
<i>FREPO</i>	Repo rate	<i>QVA</i>	Composite value-added quantity
<i>FW</i>	Financial wealth	<i>RR</i>	Reserve ratio
<i>FW1</i>	Real financial wealth	<i>SAV</i>	Savings of agents
<i>GGAP</i>	Factor demand adjustment factor (proxy for output gap)	<i>SAVF</i>	Foreign savings
<i>GDPMP</i>	Real GDP	<i>SOCCONT P</i>	Social contributions paid
<i>INTINCT</i>	Interest income	<i>SOCCONTR</i>	Income from social contribution
<i>INTEXPBOND</i>	Real interest expenditure bonds	<i>U</i>	Household Utility
<i>INTEXP1</i>	Real interest expenditure	<i>WF</i>	Economy-wide factor return
<i>INV</i>	Investment	<i>YF</i>	Total factor income
<i>MPS</i>	Marginal propensity to save	<i>YI</i>	Real agent income
<i>NDVD</i>	Net dividend inflows	<i>YIF</i>	Factor income

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*Prices and interest rates*

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$$PM_t = pwm_t \cdot (1 + tm_t) \cdot EXR_t \quad A1$$

$$PE_t = pwe_t \cdot (1 - te_t) \cdot EXR_t \quad A2$$



$$PQ_t = (1 + inf) \cdot PQ_{t-1} + \theta_1^{pq} \cdot (GGAP_{t-1}^l - 1) + \theta_2^{pq} \cdot \Delta PM_t \quad A3$$

$$PQ_t \cdot QQ_t = PD_t \cdot QD_t + PM_t \cdot QM_t \quad A4$$

$$PA_t \cdot QA_t = PDD_t \cdot QD_t + PE_t \cdot QE_t \quad A5$$

$$PRC_t = (1 + ts_t) \cdot PQ_t \quad A6$$

$$PRCd_t = \Delta PRC_t \quad A7$$

$$PRC_t^e = (1 + inf) \cdot PRC_{t-1}^e - \theta^p \cdot (PRC_{t-1}^e - PRC_{t-1}) + \theta^{prce} \cdot (GGAP_{t-1}^l - 1) \quad A8$$

$$PEQ_t = \left( (1 + ss^{peq}) \cdot (1 + PRCd_t^e)^{\mu_1^{peq}} \cdot (\Delta SL_t^{fincd})^{\mu_2^{peq}} \cdot (\Delta QA_t)^{\mu_3^{peq}} \right) \cdot PEQ_{t-1} \quad A9$$

$$FREPO_t = 0.7 \cdot FREPO_{t-1} + 0.3 \cdot (inf + 2.0 \cdot (PRCd_t - inf) + 0.35 \cdot (GGAP_{t-1}^l)) \quad A10$$

$$FRATEB_t = FREPO_t + DFRATEB_t \quad A11$$

$$FRATECD_t = 0.6 \cdot FREPO_t + 0.4 \cdot FRATEL_t \quad A12$$

$$FRATEL_t = FREPO_t + DFRATEL_t \quad A13$$

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*Production and trade*

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$$QVA_{cst} = \alpha_{cst}^p \cdot \sum_f \left( \delta_{fcs}^p \cdot QF_{fcst}^{-\rho_{cs}^p} \right)^{-1/\rho_{cs}^p} \quad A14$$

$$WF_{ft} = PVA_t \cdot QVA_t \cdot \sum_{f'} \left( \delta_f^p \cdot QF_{ft}^{-\rho^p} \right)^{-1} \cdot \delta_f^p \cdot QF_{ft}^{-\rho^p-1} \quad A15$$

$$QINTA_t = inta \cdot QA_t \quad A16$$

$$QVA_t + QINTA_t = QA_t \quad A17$$

$$QA_t = \alpha^t \cdot \left( \delta^t \cdot QE_t^{\rho^t} + (1 - \delta^t) \cdot QD_t^{\rho^t} \right)^{1/\rho^t} \quad A18$$

$$\frac{QE_t}{QD_t} = \left( \frac{PE_t}{PDD_t} \cdot \frac{(1 - \delta^t)}{\delta^t} \right)^{1/(\rho^t-1)} \quad A19$$

$$QQ_t = \alpha^q \cdot \left( \delta^q \cdot QM_t^{-\rho^q} + (1 - \delta^q) \cdot QD_t^{-\rho^q} \right)^{-1/\rho^q} \quad A20$$

$$\frac{QM_t}{QD_t} = \left( \frac{PDD_t}{PM_t} \cdot \frac{(1 - \delta^q)}{\delta^q} \right)^{1/(1+\rho^q)} \quad A21$$

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*Incomes and expenditures*

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$$YF_{ft} = WF_{ft} \cdot QF_{ft} + EXR_t \cdot yfmrow_t \quad A22$$

$$YIF_{ft}^i = shif^i \cdot (YF_{ft} - EXR_t \cdot yfrow_t)$$

$$DVDP_t^{ii} = (1 - td_t^{ii}) \cdot PRC_t \cdot YI_t^{ii} - SC_t^{ii} - OIP_t^{ii} - IEXP_t^{ii} - SAV_t^{ii} \quad A23$$

$$\begin{aligned} PRC_t \cdot INTEXP1_t^i &= FRATEL_{t-1} \cdot BSLIB_{t-1}^{i,l} + FRATECD_{t-1} \cdot BSLIB_{t-1}^{i,cd} \\ &\quad + INTEXPBOND_t^i \end{aligned} \quad A24$$

$$INTEXPBOND_t^i = FRATEB_{t-1} \cdot d_{lib_{t-1}^{i,b}} + INTEXPBOND_{t-1}^i \quad A25$$

$$DVD_t^i = DVDCOEF_t^i \cdot \left( \sum_{ii} DVDP_t^{ii} + EXR_t \cdot DVDROW_t \right) \quad A26$$

$$INT_t^i = INTCOEF_t^i \cdot \sum_i PRC_t \cdot INTEXP1_t^i \quad A27$$

$$OI_t^i = shifoint^i \cdot \sum_i OIP_t^i \quad A28$$

$$SOCCONTR_t^i = shifosoc^i \cdot \sum_i SOCCONTP_t^i \quad A29$$

$$OIP_t^i = oipprm^i \cdot GDPMP_{t-1} \quad A30$$

$$SOCCONTP_t^i = soc\_par^i \cdot GDPMP_{t-1} \quad A31$$

$$DVDCOEF_t^{insd} = dvdcoefpar^{insd} \cdot \frac{BSASS_{t-1}^{insd,e}}{\sum_{insd} BSASS_{t-1}^{insd,e}} \quad A32$$

$$DVDCOEF_t^{row} = 1 - \sum_{isnd} DVDCOEF_t^{insd} \quad A33$$

$$INTCOEF_t^{insd} = intcoefpar^{insd} \cdot \frac{\sum_{fint} BSASS_{t-1}^{insd,fint}}{\sum_{fint,insd} BSASS_{t-1}^{insd,fint}} \quad A34$$

$$INTCOEF_t^{row} = 1 - \sum_{isnd} INTCOEF_t^{insd} \quad A35$$

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*Incomes and expenditures continued*

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$$PRC_t \cdot YI_t^i = \sum_f YIF_t^{i,f} + DVD_t^i + INT_t^i + OI_t^i + SOCCONTR_t^i \quad A36$$

$$U_0 = \sum_{t=0}^{10} \beta^t \ln(QH_t) \quad A37$$

$$INV_t^{nfin} = INV_{t-1}^{nfin} \cdot \gamma_1^I \cdot \left( \frac{\Delta PEQ_t}{\Delta PRC_t} \right)^{\gamma_2^I} \cdot \left( \frac{1 + FRATEL_t}{1 + PRCd_t^e} \right)^{\gamma_3^I} \quad A38$$

$$INV_t^{infin} = INV_{t-1}^{infin} \cdot \gamma_1^I \cdot \left( \frac{1 + FRATEL_t}{1 + PRCd_t^e} \right)^{\gamma_3^I}$$

$$QG_t = grg_t \cdot QG_{t-1} \quad A39$$

$$GDPMP_t = QH_t + QG_t + \sum_i INV_t^i + inv + QE_t - QM_t + r \quad A40$$

$$\begin{aligned} PRC_t \cdot YI_t^{gov} = & \sum_f YIF_t^{gov,f} + DVD_t^{gov} + INT_t^{gov} + OI_t^{gov} + SOCCONTR_t^{gov} + ts_t \\ & \cdot PQ_t \cdot QQ_t + ta_t \cdot PA_t \cdot QA_t + tm_t \cdot pwm_t \cdot EXR_t \cdot QM_t \\ & + \sum_{insd} td_t \cdot PRC_t \cdot YI_t^{insd} \end{aligned} \quad A41$$

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*Equilibrium conditions*

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$$QF_t^f = GGAP_t \cdot QFS_t^f \quad A42$$

$$QQ_t = QINTA_t + QH_t + QG_t + \sum_i INV_t^i + inv \quad A43$$

$$GGAP_t^f = GGAP_{t-1}^f - \alpha_1^{gap,f} \cdot (FRATEL_{t-1} - PRCd_{t-1}) + \alpha_2^{gap,f} (\Delta AD_{t-1} - \Delta ad) \quad A44$$

$$SAVF_t = pwm_t \cdot QM_t - pwm_t \cdot QE_t - TRANSF_t \quad A45$$

$$TRANSF_t = nyif + NDVD_t + NOI_t + NINT_t \quad A46$$

$$\sum_i BSASS_t^{i,fi} = \sum_i BSLIB_t^{i,fi} \quad A47$$

$$d\_lib_t^{gov,b} = PRC_t \cdot INV_t^{gov} + \sum_{fib} d\_as_t^{gov,fib} + PEQ_t \cdot d\_as_t^{gov,e} - n_t^{gov} - SAV_t^{gov} - \sum_{fi} d\_lib_t^{gov,fi} - PEQ_t \cdot d\_lib_t^{gov,e} \quad A48$$

$$\sum_i SAV_t^i + EXR_t \cdot SAVF_t = \sum_i INV_t^i + inv \quad A49$$

$$\frac{SAV_t^H}{(1 - td_t^H) \cdot PRC_t \cdot YI_t^H} = \frac{SAV_{t-1}^H}{(1 - td_{t-1}^H) \cdot PRC_{t-1} \cdot YI_{t-1}^H} \quad A50$$


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*Factor accumulation*

$$QFS_t^k = (1 - \delta) \cdot QFS_{t-1}^k + \sum_i INV_{it-1} + inv \quad A51$$

$$QFS_t^l = (1 + \rho^{lab}) \cdot QFS_{t-1}^l \quad A52$$


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*Savings*

$$SAV_t^{CB} = (1 - td_t^{CB}) \cdot PRC_t \cdot YI_t^{CB} - IEXP_t^{CB} \quad A53$$

$$SAV_t^H = (1 - td_t^H) \cdot PRC_t \cdot YI_t^H - SOCCONTP_t^H - OIP_t^H - PRC_t \cdot INTEXP1_t^H - PRC_t \cdot QH_t \quad A54$$

$$SAV_t^{gov} = PRC_t \cdot YI_t^{gov} - PRC_t \cdot QG_t - SOCCONTP_t^{gov} - OIP_t^{gov} - PRC_t \cdot INTEXP1_t^{gov} \quad A55$$

$$MPS_t^{ii} = mpsbar^{ii} (1 + MPSADJ_t \cdot mps01_t^{ii}) \quad A56$$

$$SAV_t^{ii} = MPS_t^{ii} (1 - td_t^i) \cdot PRC_t \cdot YI_t^{ii} \quad A57$$


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*Financial side*

$$FW_t^i = \sum_{fi} BSASS_{t-1}^{i,fi} + PEQ_t \cdot BSASS_{t-1}^{i,eq} + \sum_{fi} d\_lib_t^{i,fi} + PEQ_t \cdot d\_lib_t^{i,eq} + SAV_t^i - PRC \cdot INV_t^i + n_t^i \quad A58$$

$$FW1_{t,t+10}^H = FW1_{t-1}^H \cdot (1 + \mu^{fw})^{10} \quad A59$$

$$FW1_t^i = \frac{FW_t^i}{PRC_t} \quad A60$$

$$FRATEEQ_t = \frac{DVD_{t-1}^{fin}}{PEQ_{t-1} \cdot BSASS_{t-1}^{fin,eq}} \quad A61$$

$$BSASS_t^{it,fi} = (FW_t^{iii} - BSLIB_t^{iii,l}) \cdot \left( \lambda_{f0} + A_{fi,j} \cdot r_{fi,j} + \lambda_{fi,4} \cdot \frac{PRC_t \cdot YI_t^{it}}{FW_t^{it}} \right) \quad A62$$

$$PEQ_t \cdot BSASS_t^{h,e} = FW_t^h - BSASS_t^{h,e} - BSASS_t^{h,oa} - BSASS_t^{h,l} - BSASS_t^{h,b} \quad A63$$

$$BSASS_t^{fin,loans} = (1 - RR_t) \cdot BSLIB_{t-1}^{fin,cashdep} \quad A64$$

$$BSASS_t^{in,l} = ld^{in} \cdot (1 + FREPO_t)^{\beta_1^{repo}} \cdot FW_t^{in} \quad A65$$

$$RR_t = RR_{t-1} \cdot (1 + \Delta FREPO_t)^{\beta^{repo}} \cdot \left( \frac{\sum_{fi} BSASS_t^{fin,fi} + PEQ_t \cdot BSASS_t^{fin,eq}}{\sum_{fi} BSASS_{t-1}^{fin,fi} + PEQ_t \cdot BSASS_{t-1}^{fin,eq}} \right)^{\beta^{sa}} \quad A66$$

$$BSASS_t^{il,cd} = \alpha^{il,cd} \cdot \left( \frac{1 + FRATECD_t}{1 + PRCd_t} \right)^{\mu^{cd}} \cdot PRC_t \cdot YI_t^{il} \quad A67$$

$$BSASS_t^{rb,oa} = EXR_t \cdot res + sa^{rb,oa} \quad A68$$

$$BSASS_t^{rb,b} = BSASS_{t-1}^{rb,b} + d_{as}^{rb,b} \quad A69$$

$$BSLIB_t^{row,oa} = EXR_t \cdot res + slr^{oa} \quad A70$$

$$BSLIB_t^{ins,l} = \alpha^{ins,l} \cdot \left( \frac{1 + FRATEL_t}{1 + PRCd_t} \right)^{\mu^l} \cdot PRC_t \cdot YI_t^{ins} \quad A71$$

$$BSLIB_t^{row,le} = lmrow^{le} \cdot \frac{PRC_{t-1} \cdot GDPMP_{t-1}}{EXR_{t-1}} \quad A72$$

$$BSLIB_t^{fin,eq} = sl^{fin,e} + BSASS_t^{H,eq} \quad A73$$

$$BSLIB_t^{nfin,eq} = \sum_i BSASS_t^{i,eq} - \sum_{infin} BSLIB_t^{infin,eq} \quad A74$$

$$BSLIB_t^{cb,cd} = \sigma^{cd} \cdot \sum_i PRC_t \cdot YI_t^i \quad A75$$

$$BSLIB_t^{fin,cd} = \sum_i BSASS_t^{i,cd} - \sum_{ifin} BSLIB_t^{ifin,cd} \quad A76$$

$$BSLIB_t^{gov,b} = BSLIB_{t-1}^{gov,b} + d_{lib}^{gov,b} \quad A77$$

$$d_{lib}^{ing,b} = BSLIB_t^{ing,b} - BSLIB_{t-1}^{ing,b} \quad A78$$

$$d_{as}^{incb,b} = BSASS_t^{incb,b} - BSASS_{t-1}^{incb,b} \quad A79$$

$$\begin{aligned} d_{as}^{rb,b} = & SAV_t^{rb} + \sum_{fi} d_{lib}^{rb,fi} + PEQ_t \cdot d_{lib}^{rb,e} - PEQ_t \cdot d_{as}^{rb,e} \\ & - \sum_{fib} d_{as}^{rb,fib} - PRC_t \cdot INV_t^{rb} + n_t^{cb} \end{aligned} \quad A80$$

$$d_{lib}^{i,finb} = BSLIB_t^{i,finb} - BSLIB_{t-1}^{i,finb} \quad A81$$

$$d_{as}^{i,finb} = BSASS_t^{i,finb} - BSASS_{t-1}^{i,finb} \quad A82$$

$$NW_t^i = \frac{(\sum_{fi} BSASS_t^{i,fi} + PEQ_t \cdot BSASS_t^{i,e} - \sum_{fi} BSLIB_t^{i,fi} - PEQ_t \cdot BSLIB_t^{i,e})}{PRC_t \cdot GDPMP_t} \quad A83$$


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## Chapter 4 The Impact of Capital Flow Reversal Shock

### 4.1 Introduction

The normalisation in US monetary policy and its impact on global liquidity has increased concerns over capital flow reversal. Countries with high reliance on capital flows such as South Africa are likely to be affected the most.

Capital flow movements are increasingly being driven by global factors and reflect risk-taking behaviour of global financial institutions (Bruno and Shin 2015; Byrne and Fiess 2016). Financial sector dynamics are key in transmitting capital flow reversal shocks and exacerbating their impact (Joyce and Nabar 2009; Mishkin 1999). This is particularly the case when the domestic economy has large stocks of short-term foreign-denominated liabilities, which lead to a large deterioration in net wealth in the presence of a rapid depreciation of the currency (Calvo, Izquierdo, and Loo-Kung 2006). In addition, capital flow reversals can be associated with discontinuities in economic behaviour, as a result of asset bubbles bursting, which worsen the negative effects.

We argue that current DSGE models are not suited to explain the capital flow reversal shock mechanism as their representation of balance sheets and financial sector dynamics is only partial. We illustrate how in our stock-and-flow-consistent framework, a capital flow reversal shock transmits itself through the balance sheets of all institutions and how the framework generates financial accelerator effects. In our model these effects operate through the reserve management of the financial sector, the lending spread, asset prices, the balance sheets of all institutions and the feedback mechanisms from economic activity.

The results are generally small compared to the experience of other countries, but the model generates larger impacts on domestic demand compared to other studies evaluating the impact of capital flow reversal on South Africa.<sup>27</sup> The main reason behind the relatively small impacts is the low holding of foreign-denominated debt by South African institutions. A depreciation in the currency does not translate into a large rise in the liabilities of domestic institutions. However, the outflow of foreign savings still reduces the availability of savings in the domestic economy,

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<sup>27</sup> See Frankel, Smit, and Sturzenegger (2008) and Smit, Grobler, and Nel (2014)

lowers the level of intermediation and pushes loan spreads up and asset prices down. Even in the absence of large stocks of foreign debt, the capital flow reversal shock does have an impact on the domestic economy through its impact on liquidity and demand for domestic financial assets. A capital flow reversal shock is still contractionary.<sup>28</sup>

We also illustrate how our framework handles discontinuity in expectations by shortening the household optimisation period. Household expectations change from model-consistent to more myopic in the presence of a large negative shock. For example, if the reduction in lending is accompanied by the bursting of a property price bubble. This increases the household savings and reduces the household ability to smooth consumption. The impact on domestic demand is significantly larger.

## 4.2 Literature review

The reasons for capital flows reversal and sudden stops include both domestic and global factors, with perceptions of risk being an increasingly important driver (Ahmed and Zlate 2014; Brafu-Insaiddoo and Biekpe 2014; Forbes and Warnock 2012; Rey 2015; Rothenberg and Warnock 2011).<sup>29</sup> Recent research indicates that the risk-taking channel of monetary policy identified by Borio and Zhu (2012) is a major driver of capital flows. For example, Bruno and Shin (2015) find that expansionary monetary policy in the US reduces risk premium and borrowing cost for global banks, which increases funding for international subsidiaries and other regional banks as relative returns increase. Risk-taking increases beyond national borders. This result is also supported by Byrne and Fiess (2016), who find evidence that banks will actively lend to emerging markets if US long-run rates are low.

Risk perceptions are also key to the theoretical model developed by Blanchard *et al.* (2010). They link risk perception, balance sheets and capital flow movements. In their framework, capital flows are driven by agents exhibiting home bias in the presence of liquidity constraints and perceptions of higher risk. The strength of the impact depends on the stock of debt. Higher stock of debt exacerbates the home

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<sup>28</sup> This links our analysis to the recent literature on whether capital inflows are contractionary or expansionary. See, for example, Blanchard *et al.* (2016).

<sup>29</sup> Sarno, Tsiakas, and Ulloa (2016) find that global factors such as US interest rates and global risk aversion explain close to 80 per cent of the variation in global bond and equity flows.

bias and levels of risk aversion, increasing the domestic borrowing rate and leading to a larger output loss. The authors proceed to find empirical evidence supporting their theoretical model.

The importance of risk taking in driving capital flows is illustrated in empirical studies, which find perceptions of risk as a major driver of the probability of sudden stops. While domestic factors such as credit extension, economic overheating and currency overvaluation are important for the probability of sudden stops, global factors and, in particular, risk taking are playing an increasingly important role. Eichengreen and Gupta (2016) and Ghosh, Ostry, and Qureshi (2016) find that an increase in risk aversion significantly raises the probability of sudden stop.<sup>30</sup>

The impacts, especially in the case of sudden stops, can be severe – including banking and sovereign crisis with large output and employment losses (Cavallo *et al.* 2015; Eichengreen and Gupta 2016; Magud and Vesperoni 2015; Reinhart and Reinhart 2008).<sup>31</sup> The impact can be long-lasting as the impact on investment is strong and negative, largely due to a deterioration in financial conditions (Joyce and Nabar 2009).

Calvo (1998) describes the transmission mechanism for sudden stops. High share of consumption expenditure on non-tradables prevents the instantaneous adjustment of the current account to the decline in capital flows, and increases output costs. The fall in the consumption of non-tradables and the associated real devaluation increase the share of non-performing loans and bankruptcies, which tightens credit constraints in the economy, reduces the marginal and average productivity of physical capital and leads to human capital destruction. This effect is made stronger by the presence of foreign-currency-denominated debt with short maturities, which may require refinancing. Higher shares of foreign currency loans to the non-tradable sector and lower levels of trade openness exacerbate the situation as the tradable sector cannot provide a cushion against the fall in aggregate

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<sup>30</sup> At the same time, a period of higher than average flows, the so-called capital bonanza, also increases the probability of capital reversal and financial crisis as it tends to create excessive lending (Caballero 2016; Reinhart and Reinhart 2008).

<sup>31</sup> Reinhart and Reinhart (2008) provide a short review of the different definitions of sudden stops used in the literature. Episodes of sudden stop generally refer to a sudden and large decline in capital flows, which is accompanied by a significant increase in some measure of external cost of funding (Calvo, Izquierdo, and Mejia 2004; Cavallo and Frankel 2008).

demand and the deterioration in balance sheets (Calvo, Izquierdo, and Loo-Kung 2006). Through the interlinkages in the economy, the tradable sector is also affected negatively.

Further, Calvo (1998) argues that fiscal and monetary policy responses are likely to worsen the situation, especially in the presence of large foreign-currency-denominated debt. The ability of fiscal policy to expand is limited by falling revenues, rising debt costs and financial markets that may struggle to intermediate government debt. The likely pro-cyclical path of government expenditure mainly reduces the demand for non-tradables, leading to further depreciation and deterioration in financial conditions. At the same time, expansionary monetary policy that increases high-powered money is also likely to increase the devaluation. The use of reserves can offset the impact of the reversal in capital flows but it can also lead to speculative attacks.

We argue that the transmission of a capital-flow shock through the economy via the risk-taking channel is supported by a financial accelerator mechanism (Bernanke, Gertler, and Gilchrist 1999). In this case the foreign sector is the lender and the domestic economy the borrower. An increase in capital inflows reduces domestic credit constraints and increases lending. This increases asset prices and capital gains and improves the net worth of domestic institutions, encouraging further inflows.<sup>32</sup> In a second round effect this translates into further improvements in net worth. This mechanism, however, is quite different from the standard financial accelerator mechanism, which does not take into account exchange rate movements and their likely impact on the balance sheet of domestic firms. Movements in the currency can reinforce the financial accelerator mechanism. Higher capital inflows lead to an appreciation of the currency, which should eliminate the arbitrage opportunity and slow down the inflows. The appreciation, however, improves the balance sheets of those firms whose debt is denominated in foreign currency and, along with higher asset prices, encourages higher inflows (Brunnermeier *et al.* 2012).<sup>33</sup> The reversal

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<sup>32</sup> A number of studies provide evidence for the link between capital flow and asset prices; see, for example, IMF (2010), IMF (2013a) and Sá, Towbin, and Wieladek (2011).

<sup>33</sup> While the exchange rate plays a smaller role in countries that have a fixed exchange rate, the financial accelerator mechanism remains important. Magud and Vesperoni (2015) find that countries with fixed exchange rates have stronger credit extension associated with large capital inflows and create more foreign liabilities. In addition, the fixed exchange rate prevents the adjustment between



in capital flows starts a process which works the opposite way, with the exchange rate and asset prices exacerbating credit constraints. Asymmetric information and moral hazard problems in the banking sector increase and foreign funders become more likely to pull their funds out (Goldstein and Turner 1996; Mishkin 1996). Companies engage in distress sales driving down asset prices, encouraging further capital outflows and exchange rate depreciation and setting off a downward spiral (Joyce and Nabar 2009). In this case the depreciation of the currency, which is expected to stabilise the economy through its impact on competitiveness, may increase the output losses through its impact on net worth (Blanchard *et al.* 2010).

Balance sheet dynamics are central to the negative effects associated with capital flow reversal or the extreme sudden stop situation (Calvo, Izquierdo, and Loo-Kung 2006; Calvo, Izquierdo, and Mejia 2004). Mishkin (1999) argues that a reversal in capital flows has large economic impacts only if it affects the balance sheets of economic agents and in particular the balance sheet of banks. This is supported by Joyce and Nabar (2009), who find that sudden stops are associated with large negative impacts only in the presence of a banking crisis, as this leads to a disruption in intermediation and a large fall in investment. A banking crisis exacerbates any possible currency crisis as a result of the initial capital flow reversal, leading to a vicious spiral, which may lead to sovereign debt crisis (Kaminsky and Reinhart 1999; Reinhart and Rogoff 2011).<sup>34</sup>

The risk-taking behaviour and the financial accelerator mechanism are dependent on the level of financial development. The economic literature indicates that the level of financial development can have both positive and negative effects on the probability and the size of the impact associated with capital flow reversals. In the presence of a global shock, countries with less developed financial sectors experience outflows, while those with more developed financial sectors tend to attract inflows (Mendoza, Quadrini, and Ríos-Rull 2009; Farhi, Caballero, and Gourinchas 2008; Ju and Wei 2011). Demand for intermediation services and the

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the tradable and non-tradable sectors, which generates larger output losses than economies characterised by a flexible exchange rate.

<sup>34</sup>The analysis of balance sheet dynamics is also important to understand whether frictions in the economy originate on the borrower's or the lender's balance sheet and to identify the appropriate policy interventions (Brunnermeier and Oehmke 2012).

stability of the financial sector provide a pull factor for capital flows. These models, however, fail to explain why financial development may reduce the probability and severity of a capital flow crisis on the economy.

Aghion, Bacchetta, and Banerjee (2004) develop a model where the level of financial development is represented by the credit multiplier. In their framework economies with an intermediate level of financial development are most unstable. As the economic cycle turns, credit worthiness deteriorates – as cash flows decline, capital flows reverse, the credit constraint becomes more binding, and investment falls. In more financially advanced economies, the financial sector continues to provide liquidity and companies are not constrained by cash flow problems. In economies with low levels of financial development, investment is less dependent on credit extension and thus capital outflows have a less disruptive effect. Aghion *et al.* (2009) extend the model to include exchange rate volatility. They argue that high levels of financial development mitigate against the negative impacts associated with exchange rate volatility. The financial sector can support companies that are highly liquidity dependent, and their profitability is affected by movements in the exchange rate.

Several other theoretical models generate similar findings. For example, González and Ranciere (2005) develop a model driven by the incentives for the financial sector to take insurance against bank crisis. They argue that countries with intermediate levels of financial development face a higher opportunity cost of insurance represented by the marginal rate of return to investment. This leads to a higher frequency of bank crisis. Higher development translates into a decline in the marginal rate of return, which makes it optimal for banks to be fully insured. In the model developed by Dell'Ariccia and Marquez (2004), financial liberalisation is followed by poor screening of borrowers and over-lending, which translate into financial fragility. Over time, as the level of financial development rises, screening practices improve and lending grows at stable rates. Rajan (1994) develops a similar model and argues that higher levels of financial development improve bank supervision, which in turn creates better incentives for bank managers and less risk taking during good times. Empirically, Loayza *et al.* (2006) and Aghion *et al.* (2009) provide support for these models.

The discussion so far indicates that countries with high levels of financial development are more likely to attract capital flows at times of financial stress, as they can provide liquidity during capital flow reversals and have better risk sharing.

Higher levels of financial development, however, are also likely to increase the level of debt and equity flows, which, unlike foreign direct investment, are more likely to lead to capital reversal and sudden stop episodes (Caballero 2016; Forbes and Warnock 2012; Jongwanich and Kohpaiboon 2013).<sup>35</sup> This destabilising impact may reflect the fact that debt and equity flows are more dependent on the creditworthiness of domestic firms than foreign direct investment (Aghion, Bacchetta, and Banerjee 2004).

Rajan (2005) argues that while high levels of financial development have made it easier for economies to diversify across small shocks, it has also exposed them to large systemic shocks, which generate significant movements in asset prices. The underlying mechanism is based on an incentive structure which encourages risk taking by financial sector managers and herding with other investment managers on investment choices to avoid relative underperformance. This behaviour underlines the risk-taking channel of monetary policy, drives capital flow movements and leads to asset prices moving away from their fundamentals.

At the same time, this mechanism underlines the building up of asset price bubbles, which can be fully consistent with rational behaviour (Blanchard and Watson 1982).<sup>36</sup> Brunnermeier and Oehmke (2012) argue that herding of investment decisions drives bubble creation, as investors purchase overpriced assets in order to avoid being priced out of the market in the next period. This is also in line with asset price bubble models, which argue that fund managers have an incentive to herd and purchase overvalued assets as no trading may reveal that they have no ability to find undervalued assets (Allen and Gorton 1993). The process is supported

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<sup>35</sup> A key limitation in this analysis is whether the definition of foreign direct investment affects the results. Portfolio flows become foreign direct investment at some threshold point as the stake purchased in a company becomes significant. If this point is low, it will be difficult to distinguish between foreign direct investment and portfolio flows.

<sup>36</sup> In the model developed by Blanchard and Watson (1982) rational expectations and behaviour do not imply that the price of an asset is equal to its fundamental value. If others believe that extraneous events play an important part in driving the price, then it is rational to purchase the asset if one is compensated for the probability of a bubble burst. This effectively indicates that in the process of following other investment managers on investment choices, rational bubbles are likely to emerge.

by easy access to credit and the limited liability of fund managers if the markets turn against them (Allen and Gale 2000). The complexity of financial instruments associated with high levels of financial development and the inability of investors to understand the information built into these instruments reinforces the bubble creation process through theoretical models which rely on informational frictions and heterogeneous beliefs (Abreu and Brunnermeier 2003; De Long et al. 1990; Ofek and Richardson 2003).<sup>37,38</sup> At the same time, the presence of these instruments creates uncertainty with regard to who bears what losses once the bubble bursts, amplifying the negative financial and economic conditions (Rajan 2005). Finally, the bubble creation process is supported by the inability of investors to internalise the negative externality that they are causing on the financial system as leverage and maturity mismatches become excessive (Brunnermeier and Oehmke 2012).

The bursting of bubbles represents a threshold point or discontinuity driven by the continuous deterioration of some economic indicators. The sudden change links capital flow reversal episodes and financial bubbles to the literature on catastrophe theory (Thom 1976).<sup>39</sup> Harris (1979) shows the applicability of catastrophe theory and, in particular, cusp catastrophes to economic behavioural functions, including expectations. By releasing the assumption of strict-quasi concavity in the utility function, he illustrates how cusp catastrophe theory can explain discontinuities, hysteresis or divergence in the behaviour of demand in response to continuous changes in price and budget variables. Similarly, he argues that sudden changes in expectations can be explained by cusp catastrophe episodes rather than “animal spirits”. Zeeman (1974) introduces catastrophe theory to financial markets. In his model, the presence of chartists, who chase trends and have no knowledge of the true value of an asset, creates instability. As the size of excess demand of chartists increases, the cusp point is passed, leading to possible discontinuities. The reliance of Zeeman’s model on heterogeneous beliefs resembles theoretical models that rely

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<sup>37</sup> Brunnermeier and Oehmke (2012) provide a comprehensive review of the literature on asset price bubbles.

<sup>38</sup> This literature also links to the sudden stop models developed by Calvo, Izquierdo, and Mejia (2004) and Calvo, Izquierdo, and Loo-Kung (2006), which rely on information frictions to generate sudden stop episodes.

<sup>39</sup> Rosser Jr (2007) provides a comprehensive review of the literature on catastrophe theory and counterarguments to the criticisms raised. He also provides a review of other models which aim to capture dynamic discontinuities. Most of these models are similar to catastrophe theory and generate similar equilibrium surfaces.

on information frictions to explain bubble creation, providing a link between the two strands of literature.<sup>40</sup> Barunik and Vosvrda (2009) provide empirical support to the presence of catastrophe theory dynamics in financial markets. They find that cusp catastrophe models fit the data better for the financial market crash in October 1987, as that was driven by internal forces, compared to September 2001, when the crash was driven by terrorists' activities, and thus the dynamics do not conform to a cusp-catastrophe episode.<sup>41</sup>

While Calvo (2003) does not link discontinuities in his model to catastrophe theory, he presents a framework which generates a low growth or a high growth equilibrium. The point of discontinuity is defined by a critical debt value, which is related to a production parameter. Any shock that causes the economy to move beyond the critical debt value leads to a sudden stop. At that point the current account shifts to zero, creating a discontinuity.

The possible presence of discontinuities in the real economy and financial sector when bubbles burst indicates that current general equilibrium models are less suited to study sudden stops in capital flows, as these models rely on continuous behaviour in both dependent and independent variables. However, as argued by Harris (1979) and shown by Barunik and Vosvrda (2009), not all booms are followed by cusp-catastrophe crashes, which indicates that current models may capture the dynamics some times but not at all times.

A stronger criticism of current mainstream economic models used to study capital flow reversal episodes is that they do not include financial sector dynamics despite the importance of the financial sector in driving capital flows and in the transmission mechanism of capital flow reversal shocks. Mendoza (2006) provides a review of a number of small DSGE models which rely on debt-deflation mechanism and credit constraints to generate large negative economic impacts in response to sudden stop episodes. Similarly, Fornaro (2015) develops a small general equilibrium model with rational expectations, nominal wage rigidities and

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<sup>40</sup> More recently, Rheinlaender and Steinkamp (2004) extend Zeeman's model by introducing a stochastic element. In their framework, the random element tends to stabilise the non-linear dynamics. Higher share of chartist traders relative to the deterministic case is required to generate unstable behaviour.

<sup>41</sup> It is possible that higher order catastrophes may fit the data better in 2001 but this is not explored by the authors.

a financial accelerator mechanism based also on Fisher's debt deflation. The model includes the demand for foreign and domestic bonds by optimising consumers. The household collateral constraint is driven by the household land holding, which is used in the production process. An exchange rate depreciation reduces the collateral constraint by increasing output, which reduces the negative impacts associated with sudden stop. The foreign debt accumulated does not affect the net worth of the consumer or the economy. This seems to contradict the impacts identified in the literature. Ottonello (2013) develops a similar model but with a collateral constraint linked to the value of collateral in the form of tradable and nontradable income and debt denominated in foreign currency units. In this case an exchange rate depreciation creates a trade-off between the level of unemployment and the degree to which the credit constraint is binding. While these models tend to generate a financial accelerator mechanism, the financial sector is not modelled explicitly and there is no consistent stock accounting.

A different but related strand of DSGE models aims to study portfolio allocation between foreign and domestic assets, and how this generates capital flows. These models also have no financial sector or balance sheet dynamics (Devereux and Sutherland 2009; Tille and van Wincoop 2010).

Some macro-prudential liquidity stress-testing tools such as the model developed by Neagu and Racaru (2013) capture detailed balance sheet dynamics and have been used to study the impact of capital flow reversal on the banking sector. While the financial dynamics in that framework address some of the criticisms raised against DSGE models, the model lacks real economy dynamics and is unable to identify the impacts on employment and output.

For South Africa, a number of papers look at the determinants of capital flows. Earlier papers such as Fedderke and Liu (2002) and Wesso (2001) look at overall capital flows. They find interest rate, inflation differentials, exchange rate movements, political risk, real GDP growth rate and the government deficit as important drivers of capital flows. Aron, Leape, and Tomas (2010), Ahmed, Funke, and Arezki (2005) and Rangasamy (2014) study the determinants of specific elements of capital flows and find the drivers that apply to the aggregate measure also apply to the elements. Aron, Leape, and Tomas (2010) argue that South Africa

has benefitted from large equity inflows due to its deep capital markets. This is in line with theoretical models which predict that high levels of financial development attract capital flows. They also find that risk aversion is a significant driver of both equity and overall flows and that good performance by the US stock market leads to higher flows into South Africa. The latter results, according to these authors, represent a global liquidity effect driven by higher profitability. These findings also provide support for the global transmission risk taking channel identified by Bruno and Shin (2015). Ahmed, Funke, and Arezki (2005) also find evidence that the depth of capital markets is important for capital inflows, particularly total portfolio investment and investment in debt securities. They also find that the effectiveness of law and order is an important driver of equity investment. Rangasamy (2014) provides empirical support for the argument that equity flow reversal episodes tend to be stronger than FDI and other investment flows for South Africa, in line with the international literature.<sup>42</sup>

Hassan (2015) links capital flows, in particular bond flows, to carry trade opportunities (conditions characterised by relatively high interest rate differential and low volatility). The carry trade mechanism works similarly to a financial accelerator mechanism, which generates asset price bubbles. More inflows lead to currency appreciation, which increases the carry trade returns and makes local assets even more attractive. Hassan argues that the destabilising effects of these inflows for the economy are limited, as there seems to be no relationship between the inflows and long-term rand volatility; the inflows have not created a credit boom; South Africa's capital control mechanism allows firms to take capital out of the country when the rand is strong and bring it back when the rand is weak, offsetting somewhat the carry trade effects on the economy; and, the level of exchange rate flexibility translates into lower carry trade flows compared to countries that intervene to manage their currencies.<sup>43</sup> The dismissal of the impact of carry flows on credit booms is explained by the depth of South Africa's financial markets. Local banks do not have to acquire non-core funding from abroad as they have a large deposit base and deep financial markets. However, we disagree with

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<sup>42</sup> A number of studies include South Africa as part of panel data analysis. These include, for example, Sarno, Tsiakas, and Ulloa (2016), Reinhart and Reinhart (2008) and Rey (2015).

<sup>43</sup> The last point relies on speculation by credit traders who expect that the intervention will become costly and eventually the currency will appreciate.

this argument. Our argument is that flows increase liquidity in the market, appreciate the currency, lower borrowing rates, increase asset prices and risk-taking. This can increase the probability of sudden stops.

In terms of economic impacts of capital flow reversal and sudden stops, Smit, Grobler, and Nel (2014) provide an assessment of the likely impact, using a macroeconometric model. Their results indicate that a sudden stop scenario can reduce GDP growth by 2.4 percentage points and employment growth by 0.7 percentage points. The magnitude of the impact is smaller compared to studies looking at the impacts in a sample of countries historically (Cavallo *et al.* 2015; Reinhart and Reinhart 2008). The adjustment takes place mainly through domestic demand and imports rather than exports. The recovery is quick and follows the recovery in capital flows. Smit, Grobler and Nel argue that while their framework does not include a financial sector for South Africa, this is not a significant limitation as most of South Africa's debt is denominated in local currency. This may also explain the smaller results compared to the impacts presented in the international literature. We argue, however, that the high level of financial development in South Africa is still an important factor in the assessment of capital flow reversal through the channels identified above. A similar macroeconometric model with no financial sector dynamics is used by Frankel, Smit, and Sturzenegger (2008) to generate the likely impact of sudden stops on the South African economy. The results indicate that the impact varies depending on the response of the monetary authority and the size of the exchange rate depreciation. Higher repo rates tend to exacerbate the negative short-term impacts on GDP growth, while the exchange rate depreciation tends to mitigate the negative impacts by decreasing imports and increasing exports. These authors argue that the probability of sudden stop and its impact are lower in South Africa compared to other countries as debt is mostly denominated in local currency units and it is of long maturity, the exchange



rate is very flexible and the economy is more open than other emerging markets.

44,45

### 4.3 Results

We simulate the impact of 2 per cent of GDP decline in net foreign savings over four quarters and explain the transmission mechanism in our stock-and-flow-consistent model. We compare the result from the main simulation with a scenario where the capital flow reversal shock changes the household expectations from model-consistent to more myopic. This aims to show how discontinuity in the behaviour of households affects the results and illustrates the ability of our framework to capture discontinuous behaviour. Such behaviour, as highlighted in the literature review section, can be due to a bubble bursting, which is likely in the presence of capital flow reversal episodes.

The decline in foreign savings reduces liquidity in the domestic market and requires rebalancing of investment and domestic savings in order to maintain the equilibrium. The decreased level of liquidity increases the financial sector's willingness to hold reserves. The reserve ratio in our model jumps, reducing the money multiplier and the supply of loans by the financial sector (panel 1 in Figure 4.1). The reduction in the supply of loans increases the spread over the repo rate and the loan rate rises. This is depicted in panel 2 of Figure 4.1. The trend reflects the initial fall in foreign savings inflows and the consequent recovery. The reduction in foreign savings tightens financial constraints and increases perceptions of risks and the lending spread, reducing the level of intermediation.

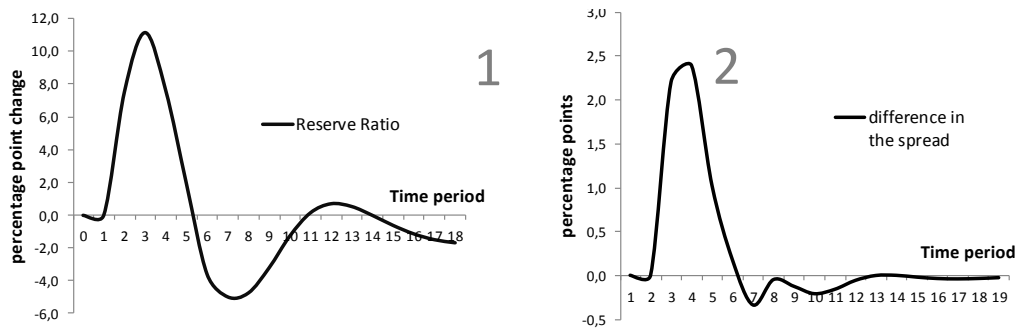
The increase in the reserve ratio is driven also by the fall in the value of financial sector assets, which is explained below.

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<sup>44</sup> IMF (2013b) also emphasises the likely impact of capital flow reversal on South Africa as a result of US monetary policy normalisation; however, they do not provide quantitative estimates of the economic impact. They argue that South Africa is likely to see a large outflow due to its twin deficits, but there are also mitigating factors such as government debt that is almost entirely denominated in rand terms and is mostly long term.

<sup>45</sup> A few studies look at the impacts of sudden stop in a sample of countries, including South Africa. However, they do not provide specific impacts for South Africa (Calvo, Izquierdo, and Mejia 2004; Cavallo *et al.* 2015; Joyce and Nabar 2009; Reinhart and Reinhart 2008). These studies tend to argue that the impacts tend to be larger than those identified by Frankel, Smit, and Sturzenegger (2008) and Smit, Grobler, and Nel (2014), especially if the sudden stop is accompanied by a banking crisis.

**Figure 4.1: Interest rate spread and reserve ratio**



Source: Model simulations

The increase in the nominal loan rate translates into higher real rate. This effect is strengthened by a fall in inflation and inflation expectations relative to the baseline (panel 1 in Figure 4.2). The output response dominates the exchange rate impact on inflation. The higher real rates affect the economy in a number of different ways:

1. Firstly, investment falls across all institutions, which helps rebalance savings and investment.
2. The increase in the real rates affects negatively aggregate demand and the demand for factors of production, which decrease utilisation in the economy and, thus, production.
3. The demand for loans decreases, thus decreasing the sources of funding available for investment in real and financial assets.
4. Interest income increases.

Table 4.1 shows the impact on investment at one ( $t+1$ ) and ten periods ( $t+10$ ) after the shock. Investment by non-financial firms is initially 3.8 per cent lower, and it is 3.9 per cent lower in the outer years despite the recovery in net foreign savings. This result is in line with the long-term impacts on investment found by Joyce and Nabar (2009). This decline reflects the permanent decline in the equity price (panel 2 Figure 4.2 below). The fall in the equity price relative to the baseline reflects a lower expectation of inflation initially, and lower growth in money supply, but more importantly the medium-term effect is driven by a permanently lower stock of capital and lower levels of capacity utilisation compared to the baseline.

**Table 4.1: Impact on real expenditure**

	capital flow reversal	
per cent deviation from baseline	t+1	t+10
Household expenditure	-2,43	-0,67
Investment		
Non-financial firms	-3,81	-3,88
Other-institutions	-4,11	-4,14
Exports	0,25	-0,97
Imports	-4,74	-0,96
GDP	-0,48	-0,97

Source: Model simulations

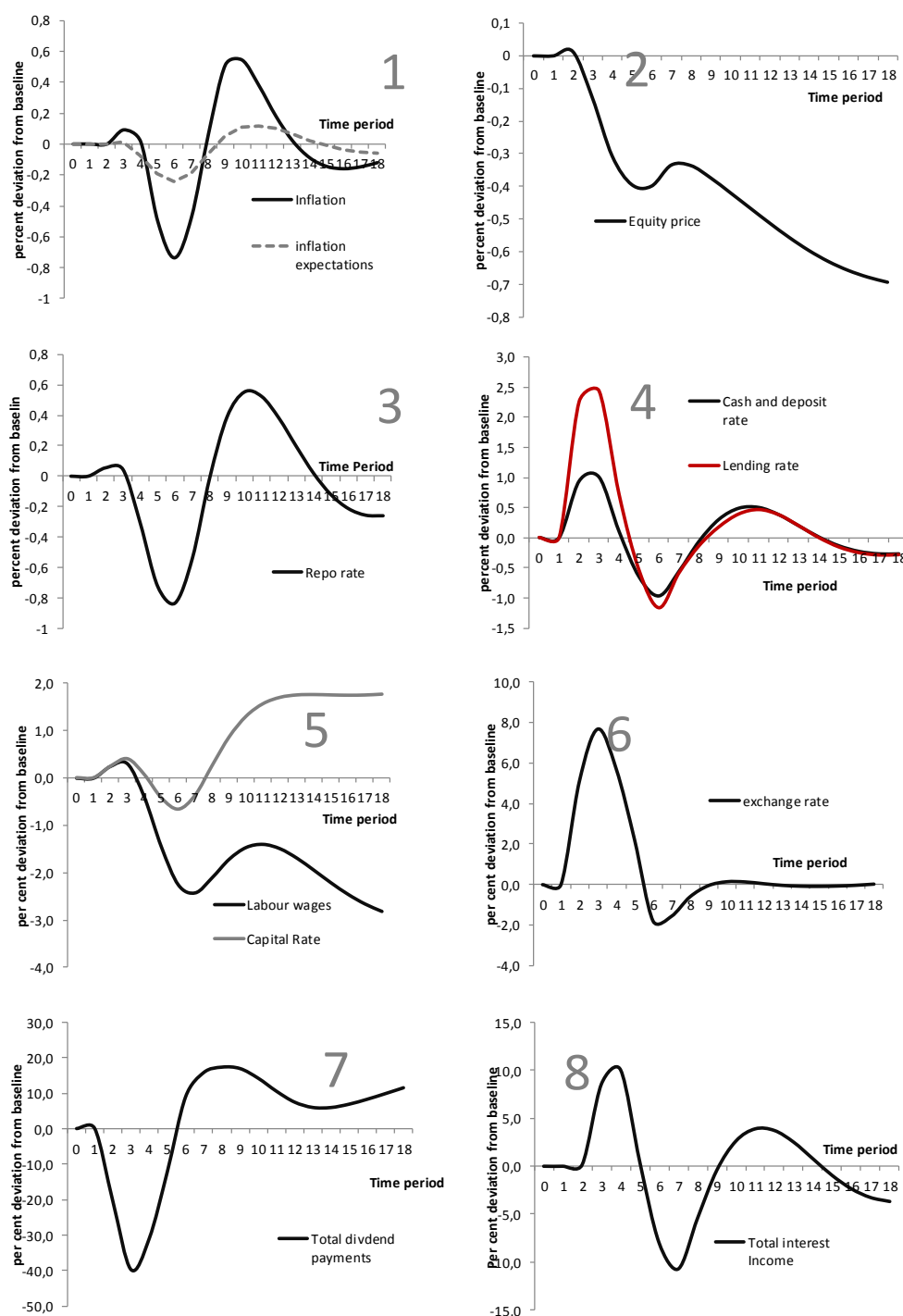
Exports and imports follow the expected trends as the reduction in foreign savings translates into a depreciation of the exchange rate (see panel 6, Figure 4.2). The decline in imports is significantly larger than the increase in exports. It reflects not only the depreciation in the currency but also the significant decline in aggregate demand.

The response is dependent on the assumed elasticities in the Constant Elasticity of Substitution and Armington functions. As the flow of foreign savings normalises and the exchange rate depreciation is reversed, the level of exports declines compared to the baseline, while the level of imports recovers but remains below the baseline level. The normalisation of imports also reflects recovery in household consumption in the outer years. As in Smit, Grobler, and Nel (2014), the main adjustment is through imports, which reduces the overall negative effect on GDP.

The lower inflation and lower utilisation of resources reduce the repo rate through the Taylor rule specification. This in turn reduces the real policy rate, and it helps to alleviate some of the pressures from the increase in the real lending rates.

The savings of the financial and non-financial sectors increase by reducing dividend payments (panel 7 in Figure 4.2 below). Total dividend payments are close to 40 per cent lower compared to the baseline, which affects negatively the income of all institutions, particularly household income.

**Figure 4.2: Impacts on rates and prices**



Source: Model simulations

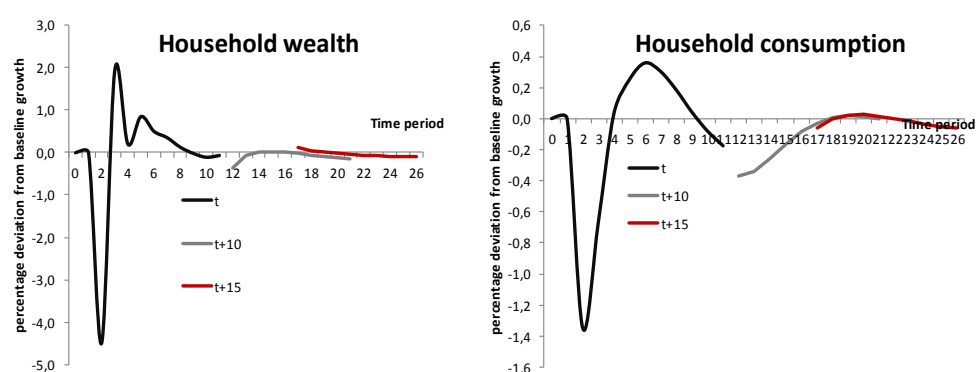
This decline in dividend income is offset somewhat for some institutions by an increase in interest income (panel 8 Figure 4.2). For households, however, the

combination of lower dividend income and higher interest expenditure reduces their ability to save and consume

Factor income also declines as capacity utilisation declines. Figure 4.2 shows divergent trends in capital and labour wages. We assume full employment. The labour force increases but economic activity is lower than in the baseline, labour wages must fall in order for labour to be absorbed. In the case of capital, the effect is more positive over the entire horizon. This reflects the fall in investment and the slower pace of capital accumulation in the scenario.

Table 4.1 indicates that the immediate impact on household consumption is large and negative; however, as foreign savings normalise, household consumption recovers marginally. There are several forces that affect household behaviour. On the one side, household income falls as explained above which translates into lower consumption. On the other side, the fall in the equity price and the lower provision of loans make it more difficult for the household to achieve its wealth target. The household needs to save more and consume less in order to compensate for the fall in the sources of funding and to achieve its desired level of future wealth and consumption. The lower level of expected inflation mitigates somewhat this impact in the short run as the household is targeting real wealth. The graphs below illustrate the adjustment process for the household.

**Figure 4.3: Household optimisation behaviour**



Source: Model simulations

The graph presents the household optimisation behaviour at three points in time: the time the shock takes place ( $t$ ), ten periods after the shock ( $t+10$ ) and 15 periods ( $t+15$ ) after the shock. The largest differences in growth rates are in period  $t$ . At

time  $t$ , the economy is faced with a sudden shock, household wealth falls. The household must consume less and save more in order to achieve its target level of wealth. Household consumption declines due to lower income and fewer sources of funding, but also a greater need to save in order to achieve its target level of wealth. The growth rates in the simulation are significantly lower initially. The household, however, expects that the simulation growth rates are going to rise and exceed those in the baseline given the cyclical structure of the economy and the likely response of monetary authorities to the shock. The stronger growth rate of financial wealth in the outer years of the optimisation period allows the households to consume more. At this point, the households cannot see that the capital flow reversal shock continues for four quarters. This expectation of future improvements lowers the impact of capital flow reversal on household consumption in period  $t$ . It allows households to smooth their consumption.

By period  $t+10$ , households face lower equity prices and the expected recovery in period  $t$  has not taken place. Household consumption growth is lower in order to maintain the growth in real financial wealth close to the baseline. By period  $t+15$ , the growth rates in the baseline and the simulation are very similar for household consumption and wealth. However, in level terms, household wealth and household consumption are permanently lower as the temporary credit constraint on the economy has reduced the stock of financial wealth compared to the baseline.

In the next tables, we present the impact on the stocks of assets and liabilities and we explain the impacts at period  $t+3$ .

The financial wealth of the foreign sector is affected mainly by the fall in savings and the depreciation in the currency. The decrease in foreign savings reduces the financial wealth available for investing by the foreign sector, while the exchange rate increases the local currency value of foreign currency denominated liabilities. The depreciation in the currency increases the value of bonds and cash and deposit liabilities relative to the baseline. We have assumed that their value is fixed in foreign currency units. The stocks of foreign loans and equity assets of domestic residents (these are liabilities for the foreign sector) are linked to domestic output. Lower domestic output and weaker domestic currency discourage domestic institutions from increasing their holding of foreign equities and loans.

**Table 4.2: Changes to the holding of financial assets**

	Assets			
deviation from baseline	Equities	Bonds	Cash and dep	Loans
t+3	simulation	simulation	simulation	simulation
Reserve Bank	-0.4	2.0	0.0	0.0
Financial sector	-0.7	5.4	-1.7	-2.9
Non-financial sector	-0.4	0.0	-1.6	-0.3
Households	-2.0	0.0	-2.2	0.0
Government	-0.4	0.0	-1.8	-0.1
ROW	-19.3	-12.6	-22.5	-14.6

Source: Model simulations

**Table 4.3: Changes to the holding of financial liabilities**

	Liabilities			
deviation from baseline	Equities	Bonds	Cash and dep	Loans
t+3	simulation	simulation	simulation	simulation
Reserve Bank	-0.4	0.0	-1.9	6.4
Financial sector	-1.4	0.0	-2.9	0.0
Non-financial sector	-10.3	0.0	0.0	-2.5
Households	0.0	0.0	0.0	-2.9
Government	-0.4	1.9	0.0	-2.2
ROW	-4.8	2.2	2.2	-4.5

Source: Model simulations

The foreign sector holding of financial assets declines across the board as the sources of funding and, in particular, foreign savings decline. The decrease in the holding of bonds is smaller compared to the other asset classes, which reflects their higher relative return.<sup>46</sup>

It is this higher relative return of bonds, which also encourages the financial sector to increase its holding of bonds (Table 4.2), which can also reflect some form of a flight to safety as bonds are associated with lower risk of default. This impact works through the Tobin asset-demand function which drives the demand for assets for the financial and foreign sectors.

The lower levels of cash and deposits received by the financial sector affect the financial accelerator mechanism in our framework. The extension of loans is lower

<sup>46</sup> Stocks where a change is not recorded reflects that the asset or liability instrument is modelled exogenously or that the institution does not hold the particular asset or liability.

because the financial sector chooses to hold more reserves, but also because the level of cash and deposits declines relative to the baseline. In addition, this negative effect on financial wealth is accompanied by a decline in equity liabilities, driven by the slower creation of equity assets by households as well as the lower equity price. The loans borrowed by the financial sector experience no change. There are two effects that determine the impact on the demand for loans by the financial sector. Higher loan rates discourage borrowing, but higher interest income encourages borrowing. These two effects offset each other. Overall, the pool of funds generated from the sources of funding and available for investment is lower relative to the baseline, despite the higher levels of net savings. All asset holdings for the sector, except bonds, decline.

The non-financial sector also funds its financial wealth through net savings, loans and equity sales. While savings increase initially, the lower demand for equities due to their lower return and lower levels of economic activity leads to a significant reduction in the equity liability for the sector (Table 4.3). At the same time, the higher loan rate and lower income decrease the demand for loans. The equity and loan effect offset the positive impacts from higher savings. The financial wealth available for investing declines, which leads to a decline in the holding of assets across the board.

The decline in the cash and deposits holding of household reflects lower income, which offsets the impact of higher cash and deposit rates. The fall in the transactional demand for money is higher than the increase in the demand for money as a store of value. The decline in financial wealth translates into a lower demand for equities on the asset side. The decline in the value of assets also reflects the fact that the representative household has achieved lower levels of wealth in the previous periods. The household's anticipation of a recovery in the economy based on its model-consistent expectations has allowed it to smooth consumption, and to save less in the initial periods of the optimisation horizon.

Government maintains its levels of spending, which translates into higher issuance of bonds given its falling income in Table 4.3. The increase in bond issuance is also driven by the fall in the other sources of funds such as loans. In terms of our specification, the decline in the loan liabilities relative to the baseline is driven by



the higher borrowing costs and the lower income of government. The marginal decrease in the government equities, both on the asset and liability sides, reflects the lower equity price as the quantity of equities is modelled exogenously. Similarly to the other institutions, the decrease in the sources of funding (liabilities) is matched by a decline in the uses of funding (assets).

The Reserve Bank sees a large increase in interest income as loan and cash and deposit rates rise. This increases the demand for loans as a source of funding, raising the financial wealth of the Reserve Bank and translating into higher purchases of bonds. Our assumption is that any increase in the financial wealth of the Reserve Bank translates into a greater holding of bonds. The stocks of all other assets are assumed exogenous.<sup>47</sup>

Below we outline the changes in net financial wealth, measured as the difference between the stock of financial assets and the stock of financial liabilities divided by nominal GDP. The results indicate that the net financial position of the country improves as a result of a reversal in capital flows. This is not surprising as the assets of the foreign sector are denominated in rand terms in our framework whereas the liabilities (the foreign assets of the domestic sector) are denominated in foreign currency units. The domestic economy benefits from the depreciation in the currency. At the same time the decline in foreign savings reduces the sources of funding and the stock of assets held by the foreign sector relative to the baseline.

**Table 4.4: Changes to net financial wealth**

Net Financial Wealth	sudden stop	
change as percent of GDP	t+1	t+10
Central Bank	0,0	0,0
Financial sector	1,1	0,3
Non-financial sector	3,4	4,2
Households	0,2	0,7
Government	-0,4	0,0
ROW	-4,3	-5,2

Source: Model simulations

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<sup>47</sup> The change in equities reflects the fall in the equity prices and not the stock of equities.

In our framework, which is stock and flow consistent, the deterioration in the net wealth of one sector must be matched by improvements in the net wealth of other sectors. In this case, the improvement takes place mainly through the balance sheets of the financial and non-financial sectors, which increase savings to offset the fall in foreign savings. For the financial sector this effect is temporary, while for the non-financial sector the impact carries throughout the simulation period. The more permanent effect for the non-financial sector is explained by the higher net savings in the outer years, which are driven by permanently lower levels of investment.

The impact on domestic demand is similar to the mild scenario of Smit, Grobler, and Nel (2014); however, our shock is significantly smaller, almost half as large. Our transmission mechanism is significantly different and assumes the amplifying effects of the financial sector, which in our framework work through the balance sheets of all institutions in the economy. The results are relatively small compared to international experiences as South Africa has a relatively low stock of foreign-currency denominated debt. This also minimises the probability of a capital flow reversal shock causing a banking crisis. However, our analysis indicates that even in the absence of foreign-currency denominated debt, the financial sector has an important role in promulgating shocks through the economy. The effect is largely through the financial sector as the foreign sector affects demand for assets and liabilities, asset prices and the money creation process.

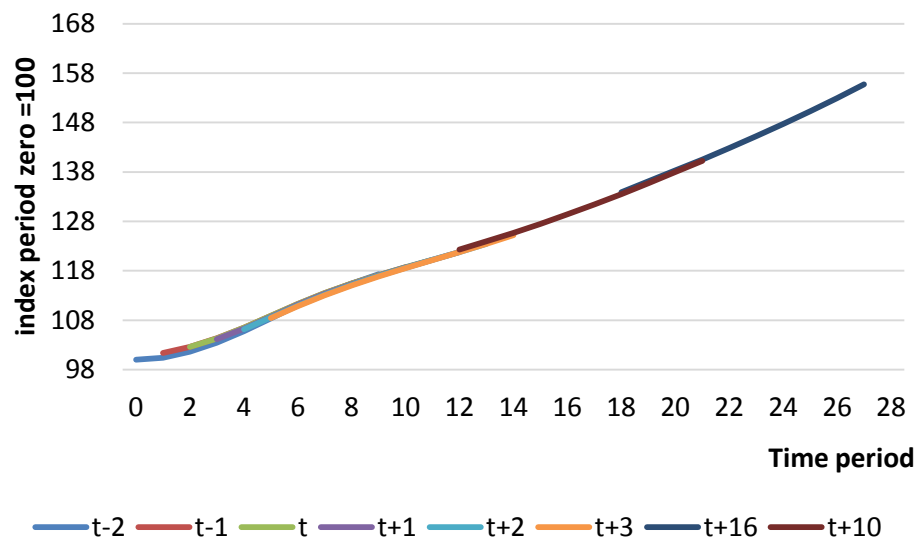
In our analysis so far, we have assumed that there is no structural change in the behaviour of institutions in response to the capital flow reversal shock. A structural change reflects a discontinuity linked, for example, to bubble bursting, as pointed out in the literature review section. General equilibrium models are continuous models and cannot handle catastrophe-theory-type dynamics. The nature of our framework, however, allows us to introduce such dynamics. While we cannot change the behaviour within periods as the household optimises, we can change behaviour between periods.

In response to a negative shock, the household shortens its optimisation period. It tries to achieve its target wealth sooner as the future looks more uncertain. Household expectations become more myopic. The simulation aims to capture the break in expectations described by Harris (1979). This is also in line with economic

literature, which shows that agents switch between different forecasting rules and excess volatility can be explained by these changes (Grandmont 1998; Hommes 2011; Roos and Luhan 2013).

In Figure 4.4, we present the baseline consumption path indexed to 100 in period zero. The household optimisation, which starts at period zero is labelled as  $t-2$ . Figure 4.4 shows that the consumption paths overlap over the solution period.

**Figure 4.4: Consumption path in the base**

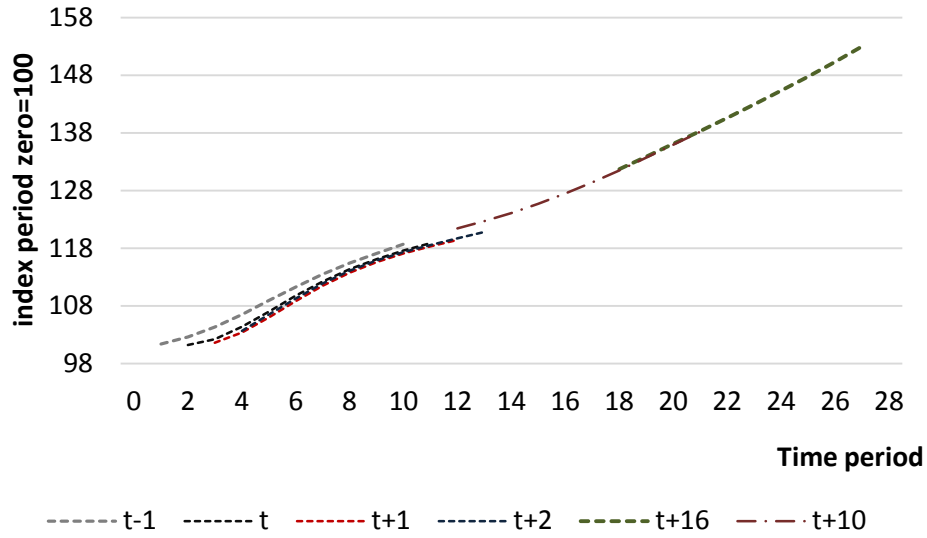


Source: Model simulations

The shock takes place in the second period. The optimisation path labelled  $t$  in Figure 4.5 has shifted to the right reflecting that households need to save more and consume less. This path reflects the growth rates depicted in Figure 4.3.

The optimisation in the next period ( $t+1$ ) follows on  $t$ . As the outer periods of the optimisation horizon are reached, the path of household consumption gets closer to the path set in period  $t-1$ . The shift in the optimisation path is also affected by the household anticipating a recovery in the economy as was highlight earlier. This leads to a lower adjustment in household consumption expenditure in the initial periods of the optimisation horizon. The outer year optimisation paths, labelled  $t+10$  and  $t+16$ , are close to the baseline path.

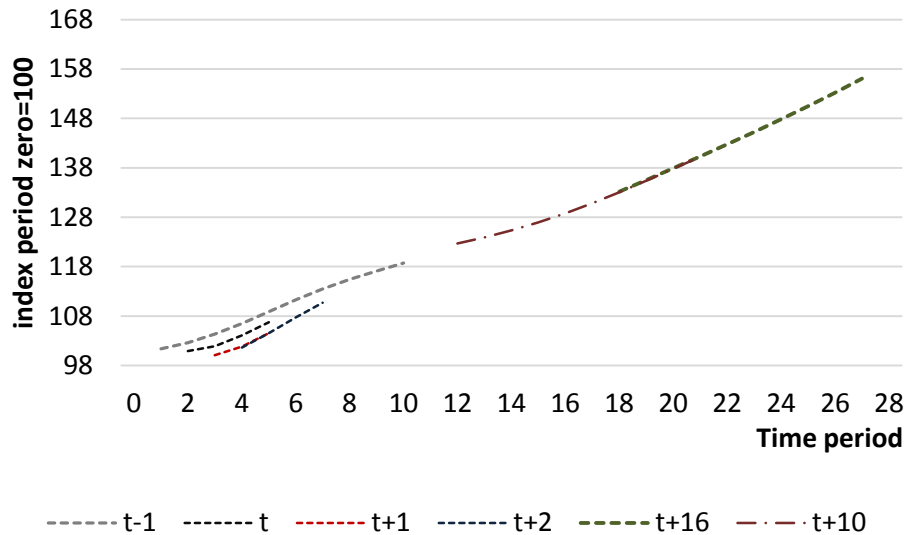
**Figure 4.5: Consumption path following a reversal in capital flows without a change in the household optimisation horizon**



Source: Model simulations

In the second simulation, we introduce discontinuity by changing household expectations from model-consistent to more myopic. The shock leads to households shortening their optimisation horizon and thus trying to achieve their level of target wealth over a shorter period. The results are presented in Figure 4.6.

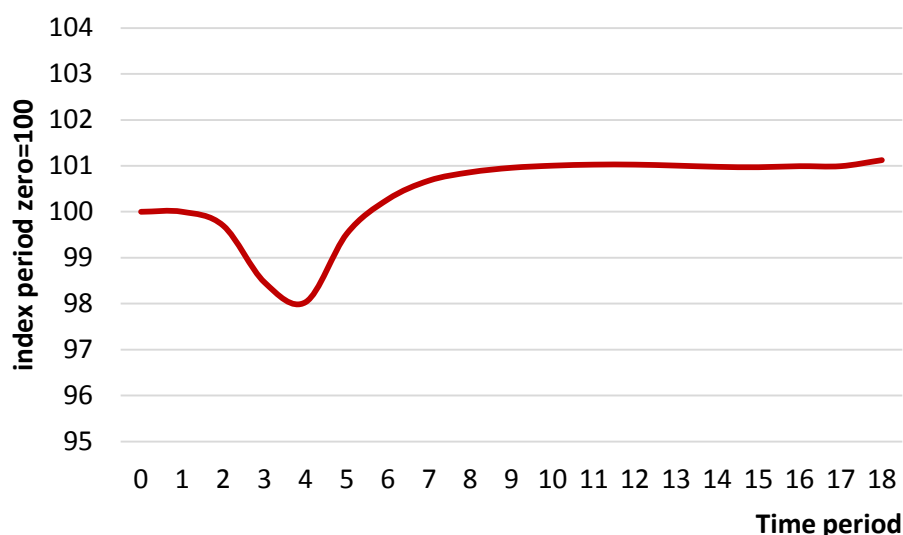
**Figure 4.6: Consumption path following a reversal in capital flows with a change in the household optimisation horizon**



Source: Model simulations

The shock is introduced by assuming that in the period when the shock takes place, households reduce their horizon to three periods, while trying to achieve the same level of financial wealth. The optimisation horizon reverses gradually as the shock is reversed.

**Figure 4.7: Ratio of consumption under simulation two to simulation one**



Source: Model simulations

The results show a larger shift to the right. The impact on consumption is larger, reflecting that the household saves more, which is a function of its expectations. Now, it cannot foresee a recovery in the economy and it has a shorter period of time to achieve its wealth target. The sudden change in expectations and consequent behaviour of the household exacerbates the negative effects associated with the capital flow reversal shock. This is shown in The shock is introduced by assuming that in the period when the shock takes place, households reduce their horizon to three periods, while trying to achieve the same level of financial wealth. The optimisation horizon reverses gradually as the shock is reversed.

Figure 4.7, which plots the ratio of consumption under simulation two to simulation one, indexed to 100 in the base year. The impact shows a larger decline in household consumption over the period associated with the capital flow reversal shock. The trend shows recovery as capital flows normalise and the optimisation period moves gradually from three periods back to ten periods. In the outer years, household consumption in simulation two is slightly higher relative to simulation

one as income is relatively higher. The higher levels of savings in the initial periods of simulation two provide for a higher stock of assets, which generates relatively higher interest and dividend income in the outer periods.

While in the first simulation, household consumption was 2.4 percent lower relative to the baseline in period  $t+1$ , now it is almost four per cent lower. The higher savings by households, however, reduce some of the negative effects on investment associated with the reversal in foreign savings. Liquidity, proxied by the growth in cash and deposits, is higher compared to simulation one, which reduces the negative impact on the financial sector's reserve ratio. This leads to a lower loan rate and higher investment compared to simulation one.

#### 4.4 Conclusion

Our main result is that even in the absence of a large stock of foreign-currency-denominated debt, a capital flow reversal shock can still generate a sizable impact. The reduction in capital flows reduces liquidity in the domestic market and increases the need to raise the level of domestic net savings. Financial sector perceptions of risk increase, which encourages the sector to hold more reserves and reduces the supply of loans. This pushes the lending spread and reduces the equity price. Economic activity declines. The real economy effects feed back to the financial sector through the balance sheets of all institutions, creating a financial accelerator effect.

The results can be significantly larger if there is a change in the expectation formation process of households. We introduce a discontinuity in our framework, which worsens the real economy impacts and increases volatility. As indicated before, such discontinuity can be linked, for example, to a property bubble bursting.<sup>48</sup>

In terms of policy implications, our analysis indicates that in the absence of large foreign-currency denominated liabilities, capital flow reversal shocks still affect the domestic economy through their impact on financial markets and possibly

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<sup>48</sup> While we have chosen to introduce discontinuities in the solution process by changing the household expectation formation, there are also other ways to introduce this type of behaviour. These include changes to the functional specification of the model as well as some of the parameters.

expectations in the economy. Our analysis provides support to the framework developed by Blanchard *et al.* (2016). While developments in the global economy are increasingly a driver of capital flows, there are domestic policy interventions that can prevent large negative effects. For example, domestic policies must avoid the development of bubbles during the capital flow surge, which can cause significant economic disruptions as they burst in the presence of capital flow reversal shocks. Policy makers also have significant control over liquidity in the domestic market, which if used effectively can reduce the negative effects associated with the financial accelerator mechanism. The impacts on the loan spread and asset prices are likely to be less negative and the real impacts on the economy more muted.

Despite a fall in the repo rate, the loan rate increased as the spread jumped following the decline in foreign savings. This creates a policy dilemma. A decline in the repo rate can exacerbate the foreign savings outflow by reducing the real risk-adjusted interest rate differential, which has a contractionary impact on the economy. If the economy has foreign currency denominated liabilities, the stronger depreciation will worsen the economic impacts. While this issue is beyond the scope of this paper to provide a detailed analysis, we argue that a repo rate increase may reduce lending rates by reducing the outflow of foreign savings and the increase in the lending spread. However, this is also a risky policy option because if the repo rate increase does not help to slow down the capital flow reversal or the lending spread impact is smaller than the increase in the repo rate, loan rates will be even higher and more contractionary. This highlights the need for policy makers to have a good understanding of the link between monetary policy actions, liquidity management, risk perceptions of the financial sector and the likely impact on borrowing rates.

## Chapter 5 Fiscal Multipliers in South Africa

### 5.1 Introduction

The severity of the economic recession after the 2008 financial crisis led governments across the world to adopt fiscal stimulus measures between 2008 and 2010. This, and subsequent attempts to reverse budget deficits, have been accompanied by a resurgence of economic research on the effectiveness of fiscal policy in influencing aggregate demand and GDP.

The central argument of the New Keynesian framework is that under zero lower bound conditions, multipliers are significantly larger (Blanchard and Leigh 2014; Christiano, Eichenbaum, and Rebelo 2011; Delong *et al.* 2012; Eggertsson 2009). The underlying mechanism assumes that the Taylor rule does not respond to movements in the output gap and inflation as rates are zero bound, while the increase in inflation expectations reduces real rates. This stimulates investment and consumption.

We argue that this mechanism is not sufficient to explain the larger fiscal multipliers during the post-2008 crisis. It does not capture financial sector dynamics, which were particularly important for the crisis and post-crisis periods.

The novelty of our work is that we study the impacts of fiscal policy in a model which explicitly models flows and balance sheets in the economy. We develop a small general equilibrium model that builds on Devarajan and Go (1998) and is stock and flow consistent in the tradition of Backus *et al.* (1980) and Godley and Lavoie (2007).<sup>49</sup> Unlike the standard financial accelerator mechanism, our framework captures the interlinkages of all balance sheets in the economy. In addition, it links economic activity, asset price movements, bank capital, perceptions of risks by the financial sector and lending spreads (the difference between the loan rate and the repo rate), capturing the dynamics identified by Woodford (2010) and Borio and Zhu (2012).

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<sup>49</sup> There are five specific properties of stock and flow consistent models as identified by Tobin (1982). These are precision regarding time, tracking of stocks, several assets and rates of return, modelling of financial and monetary policy operations, Walras's Law and adding up constraint.



We calibrate the model to South African data and assess the likely impact of fiscal expenditure on output after 2008. We assume away the Ricardian household assumption as it does not apply in the South African context (Mathfield 2006).

Our results indicate that the fiscal multiplier should have been in the range of 2 to 3 in the period immediately after the 2008 financial crisis given the negative output gap, the low government debt to GDP ratio, the monetary policy stance, the health of the South African financial sector and the large inflow of foreign savings into the economy. Our results are significantly different from recent studies on South Africa as well as studies looking at the size of fiscal multipliers in other emerging markets. The differences are driven by the absence of Ricardian households in our framework, the lack of supply side constraints, the unresponsiveness of monetary authorities to the closing but still negative output gap (similar to zero-bound interest rate conditions) and, most importantly, the presence of stock and flow consistent financial sector dynamics, which amplify the impact of a fiscal stimulus.

Higher fiscal expenditure increases aggregate demand, stimulating domestic economic activity in the presence of idle resources. Factor incomes increase, improving firms' profitability and household income. This translates into higher deposits with banks. The supply of loans increases as there are more deposits with the financial sector. Following the mechanisms outlined by Borio and Zhu (2012) and Woodford (2010), the acceleration in economic activity, reduces the probabilities of default and the perception of risk, and improves valuations and the net worth of the financial sector, leading to higher levels of intermediation and lower lending spreads. The decline in lending spreads stimulates economic activity further, creating a feedback loop, which operates through the balance sheets of all agents unlike the financial accelerator mechanism proposed by Bernanke, Gertler, and Gilchrist (1999). The effect depends on the inflows of foreign savings which reduce the savings constraint facing the domestic economy and allow for investment expenditure to accelerate. This result is in line with the theoretical model of Blanchard *et al.* (2016). In the absence of foreign savings, the higher multiplier is primarily driven by the higher levels of household consumption as the higher equity prices make it easier for the representative household to achieve its level of target wealth.

Our result relies on low debt agents or credit unconstrained agents – in this case government, expanding demand and fuelling a financial accelerator mechanism. The latter depends on the health of the financial sector. In a stock and flow consistent framework, this implies that the deterioration in the net worth of government is offset by an improvement in the net worth of other agents. Our results also indicate that an inflow of foreign savings can amplify the fiscal multiplier by reducing the savings constraint in the economy, strengthening the financial accelerator mechanism and allowing for more funds to be available for consumption. This result is in line with the theoretical model of Blanchard *et al.* (2016).

## 5.2 Literature Review

The mainstream theoretical mechanism to assess the size of fiscal multipliers relies on New Keynesian dynamics, which have been built into Dynamic Stochastic General Equilibrium models (Christiano, Eichenbaum, and Evans 2005; Smets and Wouters 2007). The critical assumptions affecting the size of the fiscal multipliers are monetary policy driven by a Taylor rule and inflation explained by a New Keynesian Phillips curve, Ricardian households and rational expectations combined with limited or no financial frictions and sticky prices and wages. Under the Taylor rule specification, an increase in aggregate demand will narrow the output gap, pushing (even if the output gap is still negative) the policy rate directly through the Taylor rule and indirectly through its impact on inflation via the Phillips curve. Real rates increase. This in turn affects consumption and investment negatively and leads to the familiar crowding out effect.

The Ricardian households anticipate that current fiscal expenditure will have to be offset by higher taxes in the future as they have perfect knowledge of government intertemporal constraints. This leads households to increase savings to compensate for the impact of higher taxes in the future on their permanent income, leading to lower household consumption now. The absence of financial frictions assumes away any financial accelerator effects that may amplify the positive or negative effects associated with fiscal policy decisions. The effect is offset somewhat by the assumption of sticky prices and wages, which amplifies aggregate demand effects.

Coenen (2012) studies the impact of expansionary fiscal policy in seven structural DSGE models and compares the results to two academic DSGE models. In their study, monetary accommodation and a higher share of non-Ricardian households increase the multipliers significantly. Interestingly, lower nominal rigidities translate into higher multipliers as they increase the inflationary impacts and decrease real rates in the presence of monetary accommodation. They acknowledge that the absence of financial frictions can underestimate the size of the fiscal multipliers in DSGE models.

Recent empirical research, however, indicates that fiscal multipliers tend to be larger during recessionary periods (Auerbach and Gorodnichenko 2012; Fazzari, Morley, and Panovska 2015; Owyang, Ramey, and Zubairy 2013; Riera-Crichton, Vegh, and Vuletin 2015).<sup>50,51</sup> This questions the underlying theoretical mechanisms in the New Keynesian framework.

The response of mainstream economics and the main theoretical innovations in studying the expansionary potential of fiscal policy in a recession has involved modelling its impact when the policy interest rate is at a zero lower bound, a situation that was effectively reached in the United States, the United Kingdom, and the Eurozone as the Federal Reserve, Bank of England, and European Central Bank lowered interest rates to near zero (Blanchard and Leigh 2014; Christiano, Eichenbaum, and Rebelo 2011; Delong et al. 2012; Eggertsson 2009). For example, Christiano, Eichenbaum, and Rebelo (2011) find a spending multiplier of 3.7 under zero lower bound conditions compared to a multiplier of 1.1 under normal conditions. Eggertsson (2009) finds a spending multiplier of 2.3 under zero lower bound conditions compared to 0.5 under normal conditions.

In the presence of a zero lower bound that prevents nominal interest rates falling to adjust real interest rates towards the level that would be required by a standard monetary policy rule, higher government expenditure pushes inflation expectations up, thereby reducing real rates and stimulating private consumption and investment.

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<sup>50</sup> Mineshima, Poplawski-Ribeiro, and Weber (2014) provide a comprehensive review of the recent literature on fiscal multipliers for advanced countries, and Batini, Eyraud, and Weber (2014) for emerging economies.

<sup>51</sup> For example, Auerbach and Gorodnichenko (2012) find a spending multiplier of 2.4 in recessionary conditions, while Owyang, Ramey, and Zubairy (2013) find a multiplier of 1.6 for Canada.

In a second-round effect, the reduced output gap leads to a further rise in inflation expectations and stimulates the economy (Christiano, Eichenbaum, and Rebelo 2011). Effectively, the Taylor rule mechanism is switched off at zero nominal interest rates causing real rates to fall as inflation expectations rise

The multiplier effect is likely to be stronger if the fiscal expansion is driven by measures supporting aggregate demand rather than aggregate supply as the latter tends to increase the spare capacity in the economy and deflationary pressures (Coenen 2012; Eggertsson 2009).<sup>52</sup>

In addition, the assumption regarding Ricardian households is less binding as the number of credit-constrained households increases in economic conditions characterised by zero lower bound. The Ricardian equivalence theorem relies on assumptions such as absence of credit constraints on households and similar interest rates and time horizons for government and households. There is no evidence that these assumptions hold, particularly during times of economic slowdown.<sup>53</sup>

Eggertsson and Krugman (2012) present a different theoretical model to explain the higher multipliers under zero lower bound conditions, which operates via the real stock of debt. In their framework, liquidity constrained debtors are forced to repay debt, and thus their spending depends on current rather than expected future income. Under conditions, characterised by zero bounds on nominal interest rates, expansionary fiscal policy can stop the deflationary spiral, reduce the stock of real debt and halt the deleveraging process, which in turn eases the credit constraint and supports further expansion in output. Their model works through inflation rather than expected inflation as in Christiano, Eichenbaum, and Rebelo (2011). To the extent that inflation expectations are adaptive, higher inflation today can reduce the stock of real debt, but it can also increase inflation expectations reducing real rates and amplifying the size of fiscal multipliers.

Some recent DSGE models assume that Ricardian equivalence does not hold for all households by introducing a certain share of credit constrained households. In Gali,

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<sup>52</sup> The level of hysteresis can have a significant impact on the size of the fiscal multipliers, and thus fiscal expansion measures which even support aggregate supply may have a strong positive impact on output (Delong *et al.* 2012).

<sup>53</sup> Carlin and Soskice (2015) provide discussion of the required conditions for the Ricardian equivalence theorem to hold.

Lopez-Salido, and Valles (2007), the size of the multiplier varies with the share of rule-of-thumb households and the degree of price stickiness. Higher price stickiness reduces the mark-up in the presence of a fiscal expansion. A similar mechanism is employed by Cogan *et al.* (2010). However, they find a lower multiplier as their study uses a lower share of credit constrained households and wage rigidities, which reduces the impact of a fiscal expansion on household income.

A limitation of the New Keynesian framework and the related DSGE models is the absence of financial sector dynamics. This is particularly important since recessionary conditions are often a by-product of financial sector crises, which also cause more severe economic slowdowns, accompanied by weaker recoveries (Reinhart and Rogoff 2009). Financial markets are also the main determinant of the sustainability of government debt and thus the effectiveness of fiscal policy (Afonso, Baxa, and Slavik 2011; Mitnik and Semmler 2013).<sup>54</sup> For example, Proaño, Schoder, and Semmler (2014) find that at high levels of financial stress the government debt-to-GDP level has a negative impact on economic activity, regardless of the debt levels.<sup>55</sup>

Studies employing New Keynesian models have addressed the criticism of a lack of financial sector dynamics by introducing the financial accelerator mechanism proposed by Bernanke, Gertler, and Gilchrist (1999). A fall in net worth implies that borrowers have little wealth to contribute to project finance. This creates a potential divergence between the interests of borrowers and lenders, which increases agency costs in the presence of asymmetric information. The probability of default increases as the company has less of its own funds involved in the project. The higher agency costs require that the lenders are compensated through higher premiums, which increase the external finance constraints for firms. In a second-round effect, the higher premiums lead to a further reduction in net wealth and amplify the initial effect. This effect can start with a fall in economic activity, which reduces cash flows, asset prices and profits, reducing net worth. Bernanke, Gertler,

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<sup>54</sup> The empirical literature generally finds that high government debt levels are associated with small or negative multipliers (Huidrom *et al.* 2016; Nickel and Tudyka 2014).

<sup>55</sup> Studies that do not take into account financial sector dynamics find that the threshold level varies between 70 and 90 per cent on average, depending on the sample of countries studied with developing countries likely to have lower threshold levels (Caner, Grennes, and Koehler-Geib 2010; Elmeskov and Sutherland 2012; Reinhart and Rogoff 2010).

and Gilchrist (1999) illustrate the impact of a government expenditure shock in their model. The presence of the financial accelerator mechanism magnifies the impact of an increase in government expenditure, mainly through its impact on asset prices and the related increase in firms' net worth.

A number of studies employ the financial accelerator model in a DSGE framework to study the impact of fiscal expansion on output. Fernández-Villaverde (2010) and Carrillo and Poilly (2010) find that the size of the fiscal multiplier increases in the presence of financial frictions, which work through the balance sheet of a representative firm.<sup>56</sup> Higher government expenditure increases inflation, which reduces the real value of debt stock of firms.

The mechanism is similar to Eggertsson and Krugman (2012). This improves net worth and through the financial accelerator mechanism magnifies the positive impact of the fiscal expansion. Merola (2012) also employs the financial accelerator framework, which amplifies the transmission mechanism identified by Christiano, Eichenbaum, and Rebelo (2011). The combination of nominal interest rates at the zero lower bound and a financial accelerator mechanism increases the fiscal multipliers.<sup>57</sup> The presence of financial frictions and zero lower bound conditions generates fiscal multipliers of similar size to those generated by Fernández-Villaverde (2010) and Carrillo and Poilly (2010) and significantly lower than the multipliers produced by Christiano, Eichenbaum, and Rebelo (2011) and Eggertsson (2009). Counterintuitively, it appears that the presence of financial frictions reduces the size of fiscal multipliers.

Kollmann *et al.* (2013) extend the financial accelerator model to the financial sector. In their framework the impact works through the link between net worth of the representative bank and the spread between the mortgage rate and the deposit rate. A loan default lowers bank capital, increases the spread and reduces output.<sup>58</sup> This

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<sup>56</sup> While the presence of financial sector dynamics increases the size of the fiscal multiplier, these effects are small and the multipliers are significantly lower than those found by Christiano, Eichenbaum, and Rebelo (2011) and Eggertsson (2009). The multiplier moves from just below 1 to just above 1 in the presence of financial frictions and zero lower bound conditions.

<sup>57</sup> If nominal interest rates are not at the zero bound, then the size of the multipliers decreases significantly as the real interest rate channel identified by Merola is no longer operational.

<sup>58</sup> The financial accelerator mechanism embedded in the balance sheet of banks is also used to study unconventional monetary policy questions in DSGE models (Gertler and Karadi 2011; Gertler, Kiyotaki, and Queralto 2012).

assumes that the financial accelerator mechanism applied to banks is similar to firms. The financial sector, however, has the important role of intermediation and money creation. A fall in the net worth of the financial sector has much broader implications than a fall in the net worth of other agents in the economy, both by increasing lending spreads but also by reducing the supply of intermediation services and the money multiplier (Woodford 2010). The decline in intermediation services exacerbates credit constraints in the economy and leads to a further decline in asset prices and the net worth of banks. Continuous deterioration in the balance sheet of the financial sector leads eventually to insolvency and a banking crisis.

The challenge with the financial accelerator mechanism is that it appears that only the net worth of one sector's balance sheet is important to economic activity. The balance sheets of different sectors of the economy and their interlinkages are not captured. These interlinkages can strengthen or weaken the transmission of shocks through the financial sector. In the absence of stock consistency, the mechanism cannot capture the distribution of debt, which is important to determine the sustainability of expansionary fiscal policy and the likely fiscal multiplier. More importantly, the financial accelerator mechanism is not able to capture the dynamics of risk-taking as it ignores the time varying pricing of risk and effective risk tolerance (Borio and Zhu 2012).

The omission of the foreign sector in the financial accelerator mechanism implies that the impacts of increased global liquidity are not captured. In models without financial sector dynamics, higher inflows will translate into an appreciation in the currency and a contraction in domestic activity. However, in models with financial dynamics and a foreign sector, increased global liquidity and higher inflow of foreign savings can reduce the domestic savings constraint, increase credit extension and asset prices, and support a fiscal expansion.<sup>59</sup> In the theoretical framework of Blanchard *et al.* (2016), higher inflows of foreign savings appreciate the currency but also reduce the cost of financial intermediation. If the latter effect dominates the former effect, the inflow of foreign capital can be expansionary.

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<sup>59</sup> The importance of global liquidity and capital flows relates the current discussion to the literature on monetary policy independence and the global financial cycle. For more information see Rey (2015).

Their framework, however, does not capture financial accelerator mechanisms and thus it may underestimate the impacts.

Since current New Keynesian models of fiscal policy omit other sectors' balance sheets, compositional issues are ignored and there is no consistent representation of flow of funds information between institutions. This generates results which can be misleading. For example, Fernández-Villaverde (2010) and Carrillo and Poilly (2010) argue that a cut in labour taxes will reduce inflation in the economy by increasing the supply of labour and hence reduce the fiscal multipliers. But lower labour taxes can increase the cash flow of households, improve their balance sheets and reduce their credit constraints, which can increase the size of the multipliers. This channel is missing in their analysis. There is general equilibrium on the real side of the economy but only partial dynamics on the financial side.

We argue that these are significant limitations of the current New Keynesian framework and the associated DSGE models as the presence of financial sector dynamics, which satisfy stock and flow consistency, can have a significant impact on the size of the fiscal multipliers. That this is so is indicated by empirical findings of a strong relationship between risk premia and asset prices on the one side and the impact of fiscal policy on the other (Afonso, Baxa, and Slavik 2011; Afonso and Sousa 2012; Agnello and Sousa 2013; Proaño, Schoder, and Semmler 2014).

Fiscal decisions can affect the balance sheets and net worth of all institutions in the economy. The financial sector will affect the real economy through the borrower balance sheet channel, the bank balance sheet channel and the liquidity channel as identified by BCBS (2011). The financial accelerator effect will work not only through the net worth of non-financial firms but through the net worth of all institutions in the economy and the complex inter-relationships that exist between the assets and liabilities of different institutions. The impacts will also work through the theoretical models of Borio and Zhu (2012) and Woodford (2010).

In the model developed by Woodford (2010), the lending spread is a function of the financial sector capital. Raising the level of capital is costly and leverage is limited by regulatory requirements. Shocks that impair the capital of the intermediary or higher leverage ratio regulatory requirements translate into higher lending spreads, lower volumes of lending and economic activity. Borio and Zhu (2012) also link



capital of the financial sector to bank behaviour. In their framework, the behaviour is driven by the *capital threshold effect* and the *capital framework effect*. The *capital threshold effect* arises because breaching the minimum threshold is costly for a bank. In the face of a possible breach banks will take defensive action to avoid the high costs, which will affect the availability and pricing of funding extended to customers. The *capital framework effect* influences the way the banks measure, manage and price risk, which affects their behaviour. The economic cycle changes the strength of the capital threshold effect as probabilities of default, valuations and the perception of risk change. In turn, this shifts the relative position of the banks' capital to the regulatory threshold and affects bank behaviour. The accelerator effects in both models are driven by the relationship between capital and economic activity. Higher economic activity reduces the probabilities of default and the perception of risk, and improves valuations. This reduces lending spreads and encourages further improvements in economic activity.

The implications of these mechanisms for fiscal policy is that expansionary fiscal policy which is perceived as sustainable may have a much stronger impact on the economy than the current estimates in the economic literature through its impact on economic activity directly and indirectly through its impact on bank capital. At the same time, unsustainable expansion can have a much more negative impact than currently anticipated.

In addition, balance sheet dynamics play an important role in understanding how funding of government expenditure affects the economy. For example, the financial sector facilitates the movement of funds from non-government institutions to government. If funders disinvest from other asset classes, this will affect the price of these assets and possibly the net worth of some individuals and companies.<sup>60</sup> These will have broader implications for the economy. Raising funds to purchase government bonds will depend on the health of balance sheets in the economy. Similarly, fiscal decisions to fund expenditure through direct taxes can affect the after-tax income and profits and the ability of households to service their debt and for companies to provide dividends. This can also have implications for the institutional balance sheets and the net worth of market participants. If no other

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<sup>60</sup> In addition to issues of net worth, if for example equity prices fall, market values will fall and investment can decline through a Tobin's Q process.

institutions are willing to purchase government bonds due to the health of their balance sheets, it will be left to the Central Bank to purchase them and then the fiscal expansion will be reduced to unconventional monetary policy (Borio and Disyatat 2010). Capturing these relationships requires stocks and flow consistency.

Recent studies on fiscal multipliers in South Africa do not incorporate financial sector dynamics. Jooste, Liu, and Naraidoo (2013), employing a DSGE model, a structural vector error correction model and a time-varying parameter vector autoregressive model, find that countercyclical fiscal policy has been effective in South Africa; however, the impact has been often less than unity in the short term and there is no impact on GDP in the long term. The largest multiplier is reached after five quarters and is equivalent to 0.6. These authors argue that the small multiplier reflects high imports leakage, which is common for open economies. Mabugu *et al.* (2013), employing an intertemporal CGE model, find that government expenditure can have a positive impact if it is on investment and this translates into higher productivity. Other types of expenditure tend to have very small multipliers close to zero.<sup>61</sup> Akanbi (2013) uses a macro econometric model to study the impacts of fiscal policy in South Africa and finds that multipliers associated with demand side interventions tend to be smaller if the economy is supply side constrained. The multipliers are just below one even in conditions characterised by a negative output gap and decline to zero within 3 years of the shock.

Our framework is also different to other studies looking at emerging markets. These also have no financial dynamics and the multipliers tend to be small. Such studies do not identify specific periods or conditions which affect the size of the multipliers. The results are based on time-series analysis, dominated by vector autoregressive techniques, which average the impact of fiscal decisions on the economies over a fairly long period of time in order to satisfy requirements regarding the number of observations. Thus, they provide limited insights whether, under recessionary conditions with falling asset prices, fiscal multipliers are large or small, and what drives their magnitude.

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<sup>61</sup> The model seems to be supply constrained and only interventions that increase the supply side of the economy lead to positive multipliers with a significant lag.

Jha *et al.* (2014) employ a Structural Vector Autoregressive (SVAR) model to study the impacts of tax cuts and government expenditure in ten Asian economies. They find that on average tax cuts have a greater countercyclical impact on output than government expenditure. They argue that tax cuts stimulate investment unlike higher government consumption expenditure, which crowds out investment. They show the present values of cumulative spending multipliers, which vary from negative 3.3 in Thailand after nine quarters to positive 1.3 in India. The tax multipliers vary between negative 1.5 in Thailand and positive 2.2 in India. This result is somewhat contradicted by Hur, Mallick, and Park (2014). They find, employing both a panel data model and a SVAR model for the same ten Asian economies, that there is no significant relationship between fiscal expenditure and consumption and investment.

Jawadi, Mallick, and Sousa (2014) employ a similar methodology along with a smooth transition regression model to study fiscal policy in Brazil, Russia, India and China. Their results indicate that government spending tends to have a stronger impact than a reduction in taxes in all countries except India. A decline in taxes led to an increase in output in Brazil and China, a contraction in Russia and had no impact in India.

Our structural model allows us to capture the specific conditions around the 2008 crisis, the strong fiscal response and some unique features of the South African economy, such as a very well developed financial sector and high tax compliance. This is in contrast to emerging markets, which are generally characterised by large informal sectors and fairly low levels of financial development (Batini, Eyraud, and Weber 2014).

### 5.3 Model Changes and Simulations

There are small changes to the model to reflect the conditions immediately post the 2008 crisis. We increase the responsiveness of price expectations in equation 16 to the output gap. This implies that under a large negative output gap and with interest rates close to the lower effective bound, expectations are likely to be more responsive to changes in the output gap. This strengthens the mechanism identified by Christiano, Eichenbaum, and Rebelo (2011).

Prices and the repo rate in equations 11 and 34 respond only once the output gap turns positive. However, once the output gap becomes positive, the responses of prices and the repo rate in the model are stronger. This brings asymmetry into the model framework and creates dynamics which resemble zero lower bound conditions. Monetary policy accommodates expansionary fiscal policy as long as the output gap is negative. Equation 11 becomes

$$PQ_t = (1 + inf) \cdot PQ_{t-1} + \theta_1^{pq-q} \cdot (y_{t-1}^{gapp,l}) + \theta_2^{pq} \cdot \Delta PM_t$$

where  $\theta_1^{pq-q}$  is larger than  $\theta_1^{pq}$  and  $y_{t-1}^{gapp,l}$  is zero and becomes positive as the proxy output gap variable becomes positive.

Equation 34 is now

$$r_t^{repo} = \rho^{repo} \cdot r_{t-1}^{repo} + (1 - \rho^{repo}) \cdot (inf + \beta_2^{repo} \cdot (\pi_t - inf) + \beta_3^{repop} \cdot (y_{t-1}^{gapp,l}))$$

where  $\beta_3^{repop}$  is larger than  $\beta_3^{repo}$ . Given that the repo rate and prices respond only to a positive output gap, these changes to the model amplify the positive impact on expected real rates because of an improvement in the output gap.

Also, we introduce an additional term in the reserve ratio equation. The growth rate of savings affects the financial sector perceptions of risks. Higher growth compared to the baseline increases the ratio and thus reduces the money multiplier.

We impose a negative output gap on the model to reflect the conditions post the 2008 financial crisis. Using different methodologies for South Africa, Klein (2011) reports an output gap of negative 2.4 per cent and negative 1.4 per cent for 2009 and 2010 respectively. Ehlers, Mboji, and Smal (2013) calculate similar size output gaps, while Anvari, Ehlers, and Rudi (2014) estimate slightly more negative output gaps. We present two simulations:

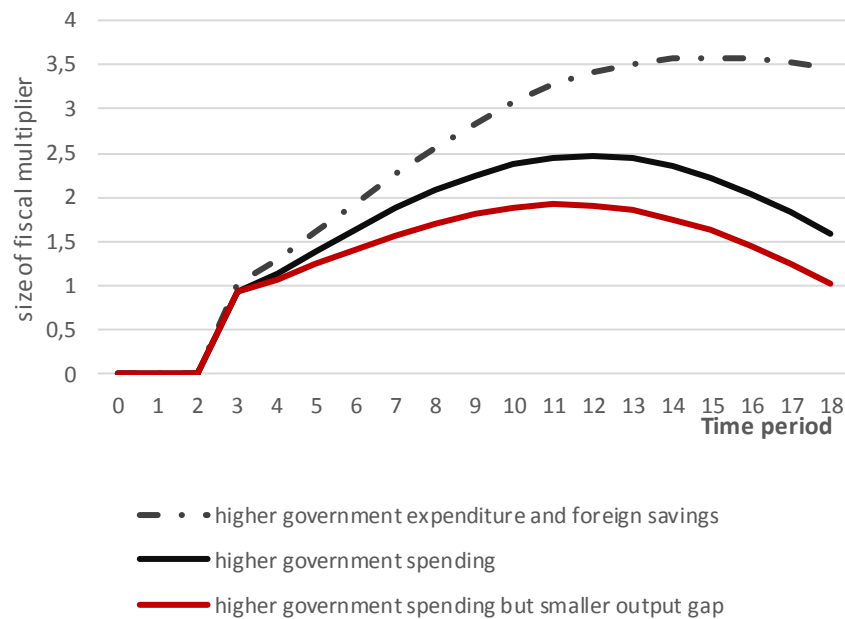
- a. A government expenditure shock of one per cent, which lasts over the entire period. In the first simulation, foreign savings is kept constant.
- b. A government expenditure shock of one per cent, which lasts over the entire period plus an increase in foreign savings inflows equivalent to one per cent of domestic savings.

All taxes are kept constant with government savings adjusting, which translates into an increased issuance of bonds.

## 5.4 Results

The results indicate the impact of government consumption expenditure under conditions of a large negative output gap, which persists over the period, a financial sector which remains sound and low government debt levels. Figure 5.1 shows the size of the multipliers under the two simulations and compares them against the multiplier if the output gap is less negative and is closed more rapidly. We show the impact multipliers as defined by Batini, Eyraud, and Weber (2014).<sup>62</sup> *Sim1* refers to the first shock with no increase in foreign savings, while in *Sim2* foreign savings also increase.

**Figure 5.1: Fiscal multipliers**



Source: Model simulations

<sup>62</sup> The impact multiplier is defined as the change in GDP at time  $t$  divided by the change in government consumption expenditure at time  $t$ . Other ways to compute the fiscal multiplier include the output change in a specific period relative to the fiscal shock in the base period, the peak multiplier measuring the largest change in output relative to the initial fiscal shock and the cumulative multiplier (Spilimbergo, Schindler, and Symansky 2009). The impact approach and the specific period approach are the most commonly used. They tend to generate marginally different results over short periods of time. In our case, we are interested in whether the multipliers are significantly larger in the presence of financial sector dynamics and thus these marginal differences are not material and we can compare the multipliers using the two approaches.

The results show that for every R1 increase in government consumption expenditure, real GDP increases by up to R2.5 as the financial sector dynamics in our framework amplify the impact of the initial stimulus. The effect increases to 3.5 if the domestic savings constraint is released. This impact persists as long as there are idled resources. If the output gap is smaller and households expect that it will turn positive soon, the multiplier is significantly smaller.

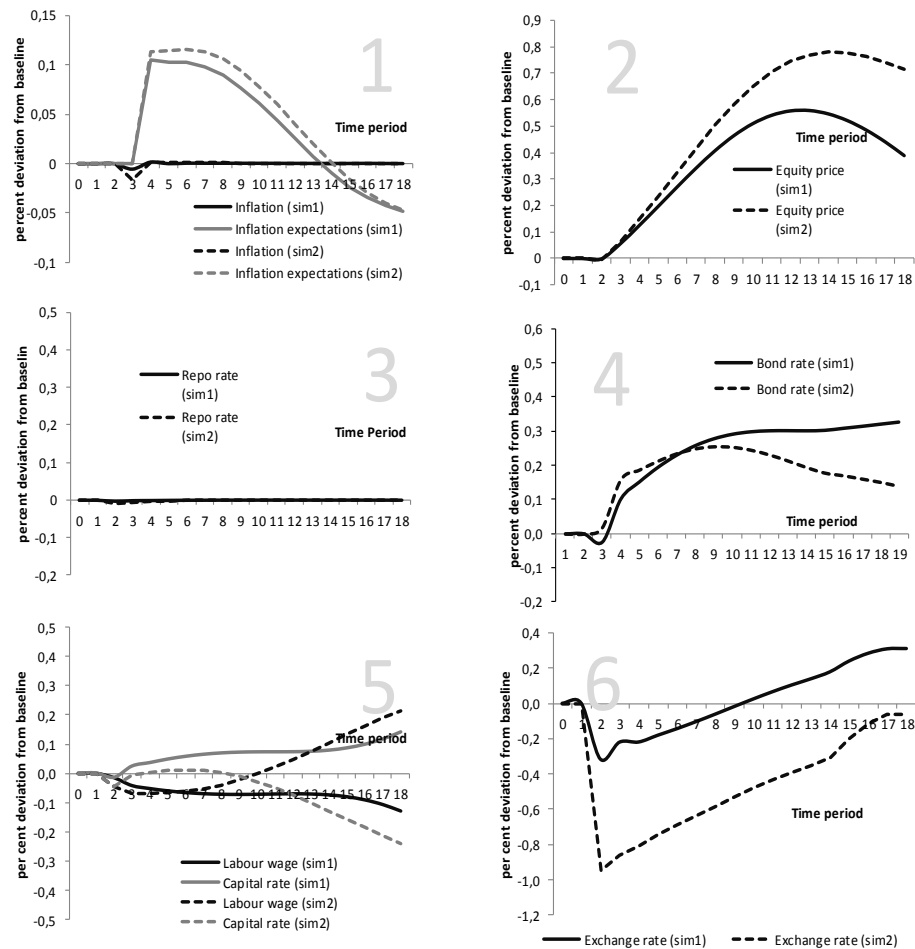
Our multipliers are much larger than those generated for South Africa by Akanbi (2013), Jooste, Liu, and Naraidoo (2013) and Mabugu *et al.* (2013). The differences are driven by the absence of Ricardian households in our framework, the lack of supply side constraints over the period, the accommodation of monetary authorities of the fiscal stimulus and, most importantly, the presence of financial sector dynamics, which amplify the impact of the fiscal expansion. Our emphasis is on the short term and under conditions of significant economic weakness rather than longer-term analysis as in Jooste, Liu, and Naraidoo (2013) and Mabugu *et al.* (2013). The size of our multipliers is more in line with studies which look at multipliers under zero lower bound conditions, such as Christiano, Eichenbaum, and Rebelo (2011) and Eggertsson (2009). However, our mechanism of achieving these high multipliers is different.

The transmission mechanism operates as follows. Higher government expenditure increases aggregate demand and demand for factors of production. This pushes inflation expectations up, as identified by as Christiano, Eichenbaum, and Rebelo (2011). The higher inflation expectations reduce real rates and stimulate investment and the demand for loans. Figure 5.2 panel 1 shows the impact on inflation expectations, which increase by 0.1 percentage point.

While inflation expectations increase, inflation and the repo rate remain unchanged as the output gap remains negative over the period (Figure 5.2 panels 1 and 3). This is in line with our specification, which assumes that the Taylor rule as well as inflation respond only once the output gap turns positive. If the monetary policy within the model framework responded as the output gap was becoming less negative, the fiscal multipliers would have been smaller. Monetary accommodation is key in generating the large impacts.

The higher inflation expectations lead to higher equity prices as shown in Figure 5.2 panel 2. The equity price also benefits from higher levels of economic activity as well as a greater supply of money as the economy expands at a faster rate.

**Figure 5.2: Impacts on rates and prices**



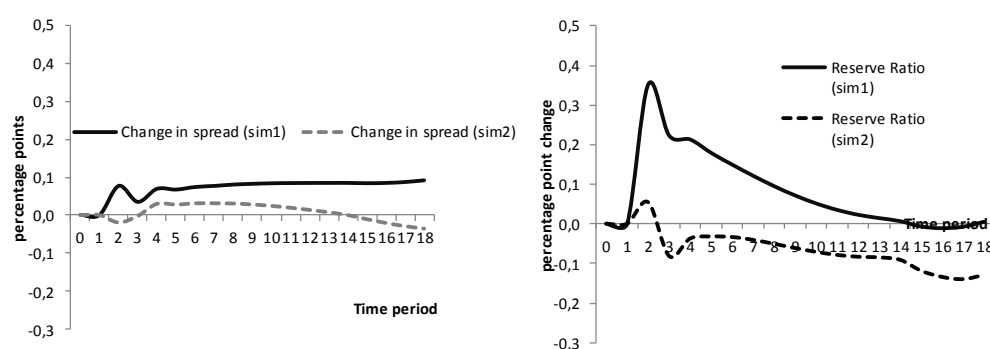
Source: Model simulations

An important part of our mechanism is how banks perceive risks and how this affects their willingness to hold reserves, which changes the reserve ratio and the money multiplier. In our specification, we linked the reserve ratio to the level of financial sector savings. Higher savings imply a higher ratio and a smaller money multiplier. The decrease in government savings due to the fiscal expansion requires that other institutions save more if foreign savings are fixed. While the higher financial sector savings increase the reserve ratio, some of the impact is offset by the higher value of bank assets and better economic activity. The net impact is a marginally higher lending spread driven by the higher reserve ratio but also by the

more rapid expansion in the demand for loans (Figure 5.3). The reserve ratio impact dissipates as the economy accelerates.

On the one side the reserve ratio is affected by the higher asset prices and stronger economic activity, which change the net worth of economic agents and risk taking, supporting a decline in lending spreads through the theoretical model of Borio and Zhu (2012) and Woodford (2010). On the other side, maintaining the regulatory capital ratios is expensive and is hindered by South Africa's savings constraint. The net impact is a marginally higher lending spread driven by the higher reserve ratio. The reserve ratio impact dissipates as the economy accelerates and the positive effect starts to dominate the negative effect.

**Figure 5.3: Impacts on the reserve ratio and interest rate spread**



Source: Model simulations

The greater supply of bonds needs to be absorbed by the various agents in the economy. As equity prices rise, the bond rate must rise to encourage the absorption of bonds, particularly by the financial and foreign sectors. These two sectors follow Tobin asset demand functions. The bond rate increases marginally by 30 basis points. These impacts reflect some crowding out effects due to the presence of a domestic savings constraint.

We now look at the real economy results, which are summarised in Table 5.1 below. We present the deviation from baseline at two points in time: at point  $t+1$ , which is the period after the shock and point  $t+10$ , which is ten periods after the shock.

In the first simulation, where foreign savings remains unchanged, the results are primarily driven by a strong response from household consumption.



**Table 5.1: Impacts on real expenditure**

	sim1		sim2	
	t+1	t+10	t+1	t+10
per cent deviation from baseline				
Household expenditure	0,08	0,49	0,35	0,90
Investment				
Non-financial firms	-0,08	-0,01	0,37	0,51
Other-institutions	-0,10	-0,11	0,03	0,58
Exports	0,14	0,57	0,04	0,70
Imports	0,32	0,49	0,73	1,01
<b>GDP</b>	<b>0,19</b>	<b>0,55</b>	<b>0,20</b>	<b>0,77</b>

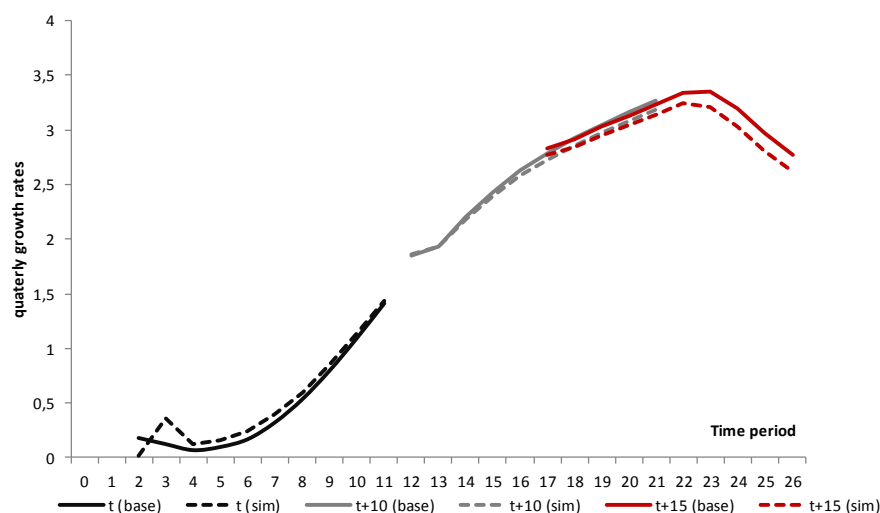
Source: Model simulations

Households see an increase in equity prices, higher flow of factor income, increase in the extension of loans and somewhat lower dividend income due to higher levels of retained earnings by the financial and non-financial sectors. The increase in factor income from capital is driven by higher utilisation leading to a higher capital rate. In the case of labour, employment increases, reducing the wage rate slightly. Based on their view of the economy, going ten periods ahead, households can afford to save less and consume more and still achieve their targeted level of wealth. This exacerbates the savings constraint more. Households effectively foresee the recovery in period  $t+10$  at period  $t$ . The increase in the supply of loans is not driven by a lower reserve ratio but by a higher level of cash and deposits into the banking system as economic activity picks up. This allows for the supply of loans to increase.

The household consumption optimisation behaviour is shown in Figure 5.4. We show the optimisation paths in period  $t$ , period  $t+10$  and period  $t+15$ . In period  $t$ , the household foresees that the economy will be expanding at a higher pace and it will be easier to achieve the household wealth target (the dotted black line showing growth rates in consumption lies above the solid line). However, as the economy recovers and in the absence of a reversal in the fiscal stimulus, the household foresees that the output gap will become positive and that monetary policy will become contractionary. The economy will slow down and it will become more difficult to achieve the household real wealth target. The growth rate slows down in the outer years compared to the baseline. The household in period  $t+15$  has to

decrease consumption growth relative to the baseline as it foresees the monetary policy contraction as inflationary pressures build up. This highlights the importance of timely and temporary fiscal stimulus. This explains also the shape of the multiplier trajectory, which peaks at period 11 and then starts to moderate.

**Figure 5.4: Household consumption path**



Source: Model simulations

Investment by non-financial institutions, which generates most of the investment in the economy, is affected positively by higher levels of production and negatively by slightly higher real rates, which leads to a small negative change in the level of investment compared to the baseline. This reflects the crowding out which is taking place in the economy. The effect is slightly stronger for other institutions. The investment results are highly dependent on the size of coefficients. Stronger response to equity prices can lead to higher investment. However, this higher investment must be matched by higher savings. Increasing the level of savings will require that the financial and non-financial sector increase the level of retained earnings and decrease the dividend payments. This also increases the loan spread, reflecting the shortages of savings in the domestic economy. There will be a short-term trade-off between household consumption and investment. However, a stronger response by investment changes the multiplier trajectory, as it expands production capacity. The recovery may be slower in the short run but the multiplier may be larger in the medium to long run.

Exports increase marginally in Table 5.1, which reflects the expansion in output. The exchange rate adjusts, given that foreign savings are fixed. Exports are fairly price inelastic. Imports increase as the currency is stronger in the short run and domestic demand increases. As the economy accelerates and dividend outflows increase, the currency depreciates. The depreciation supports export growth and makes imports more expensive.

In our framework, improvements to the net wealth of one sector can take place only through the deterioration of net wealth of another sector. Table 5.2 shows how, in the first and second simulations, the deterioration in the balance sheet of government is met by improvements in the balance sheets of other institutions. Eggertsson and Krugman (2012) argue that the distribution of debt is important as the constraints faced by agents with high debt are different from those faced with low debt. Deterioration in the net worth of agents with low debt at a time of economic slowdown improves the net worth of agents with excess borrowing, and reduces their credit constraints. In this case, the healthy balance sheet of government before the crisis allowed it to expand expenditure when other agents were constrained.

The deterioration in the net wealth of government is largely offset through improvements in the net wealth of non-financial enterprises. This reflects the increase in domestic savings generated by the non-financial sector. This is also in line with the situation in South Africa post the 2008 period, as enterprises increased their savings. The household also records some deterioration in net wealth, which reflects their increased holding of loans.

**Table 5.2: Changes to net financial wealth**

Net Financial Wealth	sim1		sim2	
change as percent of GDP	t+1	t+10	t+1	t+10
Reserve Bank	0,0	0,0	0,0	0,0
Financial sector	0,1	-0,1	0,0	-0,3
Non-financial sector	0,4	1,4	0,0	-0,5
Households	-0,2	-0,1	-0,2	-0,6
Government	-0,3	-1,1	-0,3	-0,8
ROW	0,0	-0,1	0,5	2,1

Source: Model simulations

Table 5.3 and Table 5.4 below show the changes to financial assets and liabilities in period  $t+10$  (ten periods after the shock). As expected, government issuance of bonds is 3.5 per cent higher compared to the baseline. This increase is absorbed by the financial sector and the foreign sector as the rate of return on bonds increases in order to attract financial flows. The purchases by the Reserve Bank are linked to our specification where expansion of money supply is offset through an increase in the bond holding of the Reserve Bank. An alternative approach is to have the Reserve Bank purchase foreign reserves, which will increase the sources of funds for the foreign sector and its purchases of bonds.<sup>63</sup> If the bank also increases its purchases of bonds, this will absorb a greater share of the newly issued bonds, putting less pressure on bond yields while also increasing cash and deposits in circulation. This mechanism, which is considered unconventional monetary policy, will further amplify the positive effects associated with the fiscal expansion. The higher cash and deposit will increase the supply of loans and reduce the loan spread. At the same time, the financial and foreign sectors will invest more in assets other than government bonds, supporting asset prices and deposits with the financial sector. This will further strengthen the financial accelerator mechanism in our framework.

The increase in the equity holding of the Reserve Bank as an asset and liability reflects the higher equity price. We keep the quantity of equities held by the Reserve Bank constant. The Reserve Bank also increases money supply (cash and deposits) and its loan liability as economic activity accelerates.

The financial sector decreases its holding of equities and cash and deposits as their relative return is lower than that of bonds. The growth in the liabilities of the financial sector reflect the higher levels of economic activity, which translate into higher levels of cash and deposits with the sectors as well as the higher equity prices and the increased holding of equities by the household sector. Our assumption is that the household equity assets are a liability of the financial sector balance sheet.<sup>64</sup>

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<sup>63</sup> As indicated in Chapter 2, The South African Reserve Bank uses mostly currency swaps in its management of money supply so the current specification is a departure from the actual process. However, this is unlikely to change our overall result.

<sup>64</sup> Most of the household equity holding is made of *interests in retirement and life funds*, which we have classified as equities.

**Table 5.3: Changes to the holding of financial assets**

deviation from baseline	Assets							
	Equities		Bonds		Cash and dep		Loans	
t+10	sim1	sim2	sim1	sim2	sim1	sim2	sim1	sim2
Reserve Bank	0,6	0,7	1,3	2,0	0,0	0,0	0,0	0,0
Financial sector	-0,4	-0,2	3,4	1,8	-0,5	-0,4	0,1	0,6
Non-financial sector	0,6	0,7	0,0	0,0	0,6	0,8	0,5	0,7
Households	0,2	0,0	0,0	0,0	0,6	0,8	0,0	0,0
Government	0,6	0,7	0,0	0,0	0,6	0,8	0,5	0,7
ROW	0,4	4,0	5,3	6,7	-1,0	2,8	0,8	4,1

Source: Model simulations

**Table 5.4: Changes to holding of financial liabilities**

deviation from baseline	Liabilities							
	Equities		Bonds		Cash and dep		Loans	
t+10	sim1	sim2	sim1	sim2	sim1	sim2	sim1	sim2
Reserve Bank	0,6	0,7	0,0	0,0	0,6	0,8	0,6	0,8
Financial sector	0,3	0,3	0,0	0,0	0,1	0,5	0,3	0,7
Non-financial sector	-1,7	1,7	0,0	0,0	0,0	0,0	0,2	0,7
Households	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,7
Government	0,6	0,7	3,5	2,8	0,0	0,0	0,2	0,7
ROW	1,1	1,5	0,1	-0,4	0,1	-0,4	0,6	0,8

Source: Model simulations

Similarly, the foreign sector decreases its holding of cash and deposits relative to the baseline. The higher financial wealth of the foreign sector is not driven by an increase in net savings, but by the higher equity prices and an increase in the value of equity and loan liabilities as the economy is growing faster and domestic residents invest abroad.

The household, whose asset demand is linked to its level of nominal income, increases its holdings of equities and cash deposits. The increase in the equity holding also reflects the higher equity price. The household does not provide loans, and our assumption is that it does not demand bonds due to its small holding in the underlying data. Some of the increase in the household financial wealth is financed through an increase in the holding of loans and some reflects the higher equity price.

The equity liability of the non-financial sector declines relative to the baseline, which reflects the fall in demand for equities by the financial sector. The non-financial sector provides equities to ensure that the balance between supply and demand is satisfied. Despite the fall in its ability to fund financial wealth through equity sales, financial wealth for the sector increases. This is due to an increase in

equity prices, loans taken by the sector and net savings. The holdings of assets in the form of equities, loans and cash and deposits are around 0.6 percent higher than in the baseline. The provision of loans by the financial sector is linked to the level of financial wealth: the higher the wealth, the more loans are extended. These are generally in the form of trade loans. We assume that non-financial institutions do not demand government bonds as they have a very small holding in the data used for the calibration.

In our second simulation, the fiscal shock is accompanied by an increase in the inflow of foreign savings, equivalent to roughly 1 per cent of domestic savings. This aims to capture the likely impact of the higher global liquidity post the 2008 financial crisis and South Africa's higher interest rate environment vis-à-vis the rest of the world.

This leads to a significant increase in the multiplier, which jumps from 2.5 to 3.5 (Figure 5.1). The increase in net foreign savings leads to a rise in the sources funds. The increase in foreign savings effectively reduces the credit constraint on the domestic economy and increases liquidity.

Higher foreign savings reduce the need for domestic institutions to increase savings in order to offset the higher levels of dissaving by the government. This leads to higher dividend payments as well as a decrease in the reserve ratio of the financial sector (Figure 5.3). The impact on the loan spread is significantly smaller and the impact on inflation expectations is larger (Figure 5.2). Real rates in the economy are lower than in the first simulation and lower than in the baseline.

This decline in real borrowing rates along with higher levels of economic activity supports investment by non-financial and other institutions, which increases in the second simulation (Table 5.1). The household now sees even higher equity prices, which makes it easier for it to achieve its level of targeted real wealth. In addition, household consumption is supported by higher dividend payments, higher factor payments and more extension of loans.

Net exports, however, decline compared to simulation one as the higher net foreign savings translate into a stronger currency. The net impact on domestic demand and production is positive overall and larger than in simulation one, as the GDP in the second simulation is 0.77 percent higher within ten periods of the fiscal shock.

The increase in net foreign savings leads to a deterioration in the net financial wealth of the domestic economy vis-à-vis the foreign sector (Table 5.2). Government's net financial wealth declines by less compared to the first simulation, driven by stronger revenue growth in the second simulation.

All institutions increase their holdings of loans by more than in the first simulation, driven by the lower real rates and growth in the domestic economy.

The higher bond supply is now absorbed mainly by the foreign sector, while the financial sector absorbs less compared to the first simulation, as the relative return of bonds is smaller. The Reserve Bank's increase in bond holdings is related to the increased supply of money.

The reduction in the reserve ratio leads to a greater share of the financial sector's wealth being allocated to loans. This, along with the increase in the cash and deposits liability, leads to an increase in the loans being issued by the financial sector. Equities and cash and deposit assets of the financial sector still decline marginally as the relative return of bonds is still more favourable and more financial wealth goes to loans.

The asset accumulation of the foreign sector increases across asset classes as now the sector also benefits from an increase in net savings as a source of funding relative to the first simulation. The bond and cash and deposit liability of the foreign sector falls, which reflects the stronger currency. We assume that bond and cash liabilities for the foreign sector are fixed in foreign currency units. The equity and loan liabilities increase as the stronger domestic growth and currency encourage domestic residence to diversify their portfolio and invest abroad.<sup>65</sup>

The higher demand for equities and the higher price lead to a larger increase in the equity liability of the foreign sector.

Our result, that the fiscal multiplier increases substantially with an increase in net foreign savings, contradicts somewhat studies that argue that the fiscal multiplier tends to be lower in more open economies due to import leakage (Ilzetzki, Mendoza, and Vegh 2013; Jooste, Liu, and Naraidoo 2013). While imports subtract

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<sup>65</sup> In our specification, equity and bond liabilities of the foreign sector are driven by the domestic GDP expressed in foreign currency units.

from GDP, foreign savings can reduce domestic credit constraints and support the financial accelerator mechanism in the presence of spare capacity in the domestic economy. Our results support the findings of Blanchard *et al.* (2016) that inflows can be expansionary. In our framework, however, the mechanism works through the impact on equity prices, spreads and the balance sheets of all institutions in the economy, particularly the household and financial sectors. These work together to amplify the effects of the original fiscal shock.

Finally, in Figure 5.1 above, we show the impact on the fiscal multiplier if the output gap is less negative. The red and black lines move together initially. The household foresees now that the output gap will be closed faster and inflation will start rising, leading to an increase in the policy rate. It will be more difficult to achieve its real level of targeted wealth. The household needs to save more and consume less.

In the absence of a negative output gap, the multiplier would have been negative, as monetary policy responds immediately to reduce inflation by increasing the repo rate. The effect depends on the parameters in Tylor rule (eq. 34), but also on the parameters in the equation for the financial sector reserve ratio (eq. 25). Lower value of  $\beta^{repo}$  will reduce the impact of monetary policy on the financial sector and reduce the negative impact.

South Africa's fiscal expansion could be financed easily because government finances were perceived as sustainable due to the low debt-to-GDP ratio at the time of the fiscal expansion, and the financial sector could intermediate between the purchasers of bonds and the government. If the financial sector was under stress and unable to intermediate, even in the presence of sustainable government finances, the state would have not been able to fund its expenditure and the financial accelerator effect would not have been operational. The reserve ratio in our model would be very high and the financial sector would transform its financial wealth not into loans but into cash and deposits. Under extreme financial stress, the financial sector inability to purchase government bonds would require the Reserve Bank to intervene and purchase the bonds. In this case, the fiscal expansion would be reduced to unconventional monetary policy (Borio and Disyatat 2010).



## 5.5 Conclusion

Our main conclusion is that financial sector dynamics have an important role to play in amplifying the impact of fiscal expansion under conditions characterised by large negative output gaps. The transmission mechanism works through the real lending spread over the deposit rate, asset prices and the balance sheets of all institutions in the economy, which amplify the initial fiscal shock. The sources and uses of funds are interlinked in our framework and work together to generate a financial accelerator mechanism. The balance sheet of households and the financial sector play particularly important roles. Household consumption depends on the ability of households to achieve their level of target wealth. An important part of our mechanism is the willingness of banks to hold reserves in order to manage regulatory requirements, but also risk. Following the theoretical models of Borio and Zhu (2012) and Woodford (2010), improvements in economic activity reduce risk perception and improve valuations, making it easier for banks to achieve their capital requirements, which translates into higher lending. This in turn supports further expansion in output, creating a feedback mechanism. Our results indicate that South Africa's savings constraint limits the operations of this mechanism.

Improvements in the net worth of agents with high levels of debt can increase the money multiplier and reduce credit constraints. This requires, however, a fall in the net worth of agents with low debt. Our framework allows us to trace precisely changes in flows and stocks and identify the impact of policy decisions on the balance sheets of all agents in the economy.

In terms of policy, our results indicate that policy makers need to have knowledge not only of the size of the output gap but also the health of the financial sector, its perceptions of risk and the likely impact of its decisions on economic agents, particularly those with high debt levels. The Reserve Bank has an important role to play, particularly if the ability of the financial sector to intermediate is being hindered. It can also reduce the impact on bond rates and improve the sustainability of the fiscal expansion if it purchases more bonds, increasing the supply of money and reducing bond yields. This constitutes unconventional monetary policy.

The results also indicate that the impacts of fiscal policy are linked to global economic policy developments, which affect the flows of foreign savings as well

as domestic policies which serve to attract or discourage these flows. This highlights the need for policy coordination both on international and domestic level.

## Chapter 6 The Impact of Higher Leverage Ratio

### 6.1 Introduction

In this chapter, we analyse how changes in banks' required leverage ratio affect the economy through their impact on the financial sector. The emphasis is on understanding the interaction between real and financial variables. In particular, we are interested in the impact on lending spreads, equity prices, the demand for assets and liabilities, and how the combination of these effects affect the real economy. The stock and flow consistency of our framework allows us to study how the financial sector affects the real economy but also how in second-round effects the developments in the real economy may affect the financial sector. This mechanism has important implications for monetary policy decisions, and we highlight these. The emphasis is on the short run and thus our aim is not to evaluate whether the higher levels of leverage requirements reduce the risk of crisis and default in the long run.<sup>66</sup>

The leverage ratio is equal to tier 1 capital over a measure of exposure. In the text below we use capital ratio to refer to the leverage ratio rather than the risk-adjusted capital ratio. The exposure measure generally consists of on-balance sheet exposures, derivative exposures, securities financing transaction exposures and off-balance sheet (OBS) items.

Our results indicate that the transmission of the shock and its impact depend on how the banks choose to achieve the higher leverage ratio requirements. Initially, we model the impact of an adjustment through a reduction of the banks' asset value, which takes place through all financial instruments. In a second simulation, this is accompanied by higher levels of retained earnings. The results from the first set of simulations is compared to the impact of an alternative adjustment mechanism

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<sup>66</sup> Our interest is in the short-run transition to higher capital requirements. FSB (2010) provides estimates of the long-run net benefits. They find that the net benefit of the proposed capital requirements in Basel III is around 2 per cent of GDP on average across countries. The main channel is that a well-capitalised banking system will lead to a reduction in the risk and cost of financial crises and macroeconomic volatility. Caggiano and Calice (2011) find similar results for African economies.

which assumes that the banks can raise equity capital either at no cost or at a high cost.

If banks can raise equity capital at low or no cost, the negative impacts on economic activity are small. Increasing the level of retained earnings also generates less negative results compared to achieving the ratio entirely by reducing the value of assets. This, however, negatively affects those institutions, which rely more heavily on dividend income. Shrinking the asset value of the financial sector or raising equity capital, which translates into high lending spreads, generates significant negative results.

We argue that our framework is better suited to capture capital requirements shocks than previous models used for this type of analysis internationally and in South Africa. The presence of more detailed financial behaviour, lending spreads, asset prices, and stock and flow consistency, allows for better, but not perfect, representation of the risk-taking channel of Borio and Zhu (2012) and the links between financial behaviour, economic activity and lending spreads identified by Woodford (2010).

We proceed with a review of the relevant literature. This is followed by a description of the changes to the core model to make it suitable to handle capital requirements shocks. In Section 6.4, we present our results and we compare them to those generated by South African and international studies. The conclusion follows and highlights the implications of our analysis for policy makers.

## 6.2 Literature Review

Higher capital tends to increase the probability of survival through rising the incentives for banks to monitor borrowers, attenuating asset-substitution moral hazard and reducing the appeal of risky products (Acharya, Mehran, and Thakor 2015; Allen, Carletti, and Marquez 2011; Holmstrom and Tirole 1997; Mehran and Thakor 2011; Thakor 2012). Empirically, a number of papers provide support for the positive relationship between bank capital and bank performance (Beltratti and

Stulz 2012; Berger and Bouwman 2013; Berger, Imbierowicz, and Rauch 2012; Cole and White 2012; Estrella, Park, and Peristiani 2000).<sup>67</sup>

However, they do not assess how the movement to higher capital affects bank behaviour, the economy and the feedback mechanism back to the financial sector.

A critical channel in this mechanism is how the movement to higher credit requirements affects credit extension in the short run. In the theoretical framework developed by Covas and Fujita (2009), which is based on the work of Holmstrom and Tirole (1997), the mechanism works through the dependence of capital good production on bank funding. During a downturn, agency costs increase due to higher moral hazard on behalf of entrepreneurs; this is accompanied by higher equity issuance costs and higher capital requirements for the financial sector, which exacerbate the credit constraint faced by entrepreneurs and generates a new lower steady state equilibrium.

The effect of a capital requirements shock is not necessarily negative if banks are characterised by different initial leverage ratios. Zhu (2008) develops a model where the capital requirements of banks depend on their risk profile with riskier banks having larger requirements. The decline in the capital requirements of less risky banks can offset the increase for more risky banks, reducing the negative impacts on the credit cycle. The presence of capital buffers also reduces the size of any procyclical effects. The capital buffers, however, can increase, even for well capitalised banks, in response to anticipating difficulties with raising equity in the future. This is part of the underlying mechanism in the model of Repullo and Suarez (2013). In their framework, capital buffers increase as a precaution against shocks that may hinder their future lending. The increase is larger if the regulatory regime requires higher capital during recessionary periods and for high social costs of bank failure. The model generates significant credit rationing of borrowers under recessionary conditions.

Similarly, Meh and Moran (2010) present a model where negative economic shocks reduce the profitability of the banking sector and its ability to attract funders. Since

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<sup>67</sup> Barth, Caprio, and Levine (2004) find that a higher capital requirement is associated with a decline in the non-performing loans; however, they argue that their results do not support a robust positive relationship between higher capital requirements and bank development or efficiency.

banks cannot adjust immediately, lending declines. The negative economic outcomes in the model developed by Van den Heuvel (2008) are driven by the decline in liquidity due to capital requirements. Households have high preference for liquidity and their welfare declines as banks face a reduced ability to increase liquidity through taking deposits. Besanko and Kanatas (1996) argue that higher capital requirements may have a perverse impact on insiders and increase rather than reduce risk taking. As the value of their portfolio is diluted, they generate less value from the performance of the loan book. This decreases their oversight on loans and increases risk taking.

These models, however, do not provide a comprehensive framework to study the impact of higher capital requirements on the economy. They fall short in addressing how capital requirements affect the transmission of other policies, particularly monetary policy, and how they affect the measurement and distribution of risk. They provide no explanation as to how changes to capital requirements affect the balance sheets of various institutions in a general equilibrium framework and how these balance sheet effects interact and affect economic activity. There is only a limited representation of financial instruments, and thus the frameworks are highly stylised and unable to illustrate distributional impacts through changes in portfolios. More importantly, the theoretical models do not internalise the financial accelerator and risk-taking channel, which characterise the operations of the financial sector, or the linkages between bank capital, the level of intermediation and the lending spread (Bernanke, Gertler, and Gilchrist 1999; Borio and Zhu 2012; Woodford 2010).

The model developed by Borio and Zhu (2012) presents a framework which explains how regulatory capital requirements affect the behaviour of the financial sector. In their model, the impact of higher capital requirements affects the financial sector directly through the *capital threshold effect* and the *capital framework effect*. The *capital threshold effect* arises because breaching the minimum threshold is costly for a bank. In the face of a possible breach, banks will take defensive action to avoid the high costs. These high costs are driven by restrictive supervisory actions and reputational costs. In turn, this will affect the availability and pricing of funding extended to customers. This can translate into an increase in lending spreads. The effect is particularly strong and can affect the ability of the financial

sector to extend credit when increasing the capital base is more costly than alternative funding sources at the margin.<sup>68</sup> Even in the absence of an immediate threat of breaching the minimum requirement, the capital threshold effect may be operational. Borio and Zhu (2012) argue that in this case the effect is a cost or a tax which varies with the size of the cushion over the minimum and with its volatility. At the same time, the size of the cushion is a function of the business cycle and idiosyncratic shocks to the bank's balance sheet. In our framework, we assume that the banks always achieve and operate at the minimum requirement. A shift in the leverage ratio triggers the *capital threshold effect*.

The *Capital framework effect* influences the way banks measure, manage and price risk, which affects their behaviour. The economic cycle changes the strength of the capital threshold effect as probabilities of default, valuations and the perception of risk change. In turn, this shifts the relative position of the banks' capital to the regulatory threshold and affects bank behaviour. This can increase lending, improve net worth of agents across the economy and support economic activity further, creating a multiplier effect.

The mechanism is affected by the response of monetary authorities as interest rates affect cash flows, net interest rate margins, earnings and the valuation of assets, which again affect the relative position of the bank capital relative to the regulatory threshold. Reductions in the policy rate can decrease the returns from certain assets and encourage risk taking in order to achieve target rates of return. Monetary policy can also affect risk behaviour through communication policies and the central bank reaction function. Through its communication, the central bank can increase transparency, reduce uncertainty and compress risk premia. The perception that the central bank reaction function is effective in reducing downside risks can increase risk taking. The impact depends on the composition of balance sheets and the financing constraints faced by agents in the economy. This mechanism also operationalises the risk-taking channel in the framework, which is defined as the impact of changes in policy rates on either risk perceptions or risk-tolerance.<sup>69</sup>

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<sup>68</sup> Borio and Zhu (2012) provide reasons why increasing the capital base is more costly than alternative funding sources at the margin. These include, for example, cutting dividends may signal relatively poor performance; or, taxation may favour debt over equity.

<sup>69</sup> The presence of the risk taking channel is supported by empirical studies such as Adrian and Shin (2010).

Liquidity and risk-taking are tightly interconnected and can reinforce each other. Lower perceptions of risks and higher risk tolerance weaken external funding and transferability constraints and hence increase liquidity. At the same time, weaker liquidity constraints can support higher risk-taking.

The financial accelerator mechanism in the framework developed by Borio and Zhu (2012) works through the regulatory regime; the impact of the cycle on probabilities of default, valuations and the perception of risk; and the monetary policy decisions as explained above. In addition, the mechanism is supported by the mutually reinforcing relationship between risk-taking and liquidity.

Woodford (2010) presents a theoretical framework which links the capital of the intermediaries, the supply of intermediation services and economic activity. The willingness of financial intermediaries to provide services depends on the lending spread, the margin that they can charge over the interest rate paid to savers.

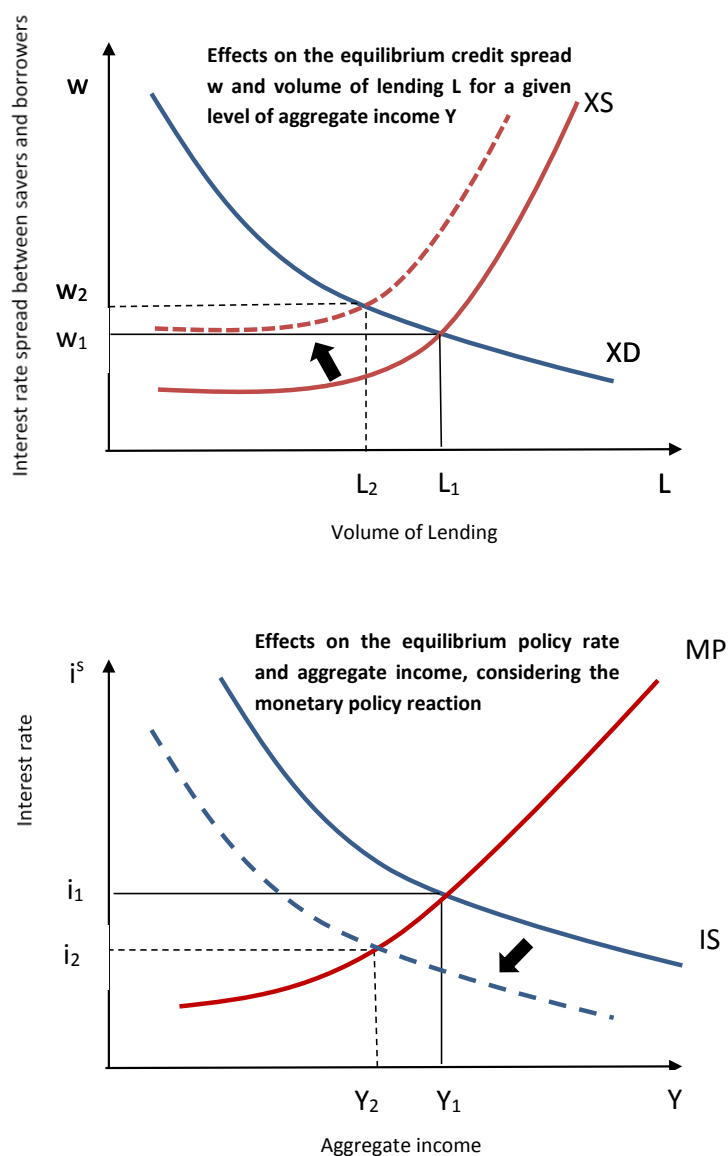
The lending spread reflects the marginal costs of intermediation. These costs are an increasing function of the volume of lending as intermediaries have limited capital. Increasing capital is likely to be costly and increasing leverage is limited by regulatory capital requirements. Raising funds through loans is constrained by the intermediaries' collateral. This indicates that for a given quantity of capital, the supply schedule for intermediation services will be upward sloping, as XS in Figure 6.1. The demand for intermediation is represented by the schedule XD, which shows the willingness of borrowers to pay to induce savers to supply funds. This is a profit opportunity for the intermediaries to the extent that the cost of intermediation is low. The schedule XD reflects a certain level of income. Changes to income shift the demand for intermediation. This establishes a relationship between interest rates, income and the level intermediation, which is represented as an IS curve in the second panel of Figure 6.1.

Shocks that impair the capital of the intermediary or higher regulatory leverage ratio requirements will shift the XS curve up and to the left. The equilibrium credit spread increases and the volume of lending declines for any given level of economic activity (Y). This implies that the rate paid to savers declines while the rate paid by borrowers rises for the given level of Y. This is true for each possible value of Y,



which leads to a shift in the IS curve down and to the left.<sup>70</sup> If the monetary policy reaction function (represented by MP) remains the same, the shift of the XS curve leads to a lower policy rate and a decline in economic activity.

**Figure 6.1: Graphical representation of the model (Woodford 2010)**



Source: adopted from Woodford (2010)

The framework can generate financial accelerator effects. For example, the initial decline in economic activity is likely to reduce the net worth of financial intermediaries and the volumes of loans for any given credit spread. This will shift

<sup>70</sup> The IS schedule plots the equilibrium value of the rate paid to savers ( $i^s$ ) because the policy reaction function targets  $i^s$  rather than the rate paid by borrowers.

the XS curve further to left. The secondary effects if caused by changes to the capital of the intermediary are likely to be more persistent than the initial shock. If intermediaries are required to sell assets in a systemic manner, this can create a vicious spiral that reduces the capital of intermediaries and the loan supply.

We view the two frameworks as complimentary and fundamental to our analysis. Woodford (2010) provides an explicit link between bank capital, level of intermediation, interest rate spreads and economic activity. The analysis of Borio and Zhu (2012) provides more support as to why intermediaries may be facing an upward sloping supply curve for intermediation services, and links the risk-taking behaviour of the financial sector, which is a source of financial accelerator effects, to how it measures, manages and prices risk. This is not only a function of the balance sheet of the financial sector, but rather of how the financial sector views the distribution of risk across the economy.

Recent macroeconomic assessments of higher capital requirements are related to the introduction of BASEL III. The studies do not model risk-weighted assets, hence their results are more applicable to the likely impact of higher leverage ratio requirements on the economy than the impact of risk-weighted capital requirements. The short-term impacts are generally negative. MAG (2010b) finds small negative impacts in the short run with small variations, which are dependent on the tool used to assess the impacts, the response of monetary policy and the spillover effects across countries. The impacts are largely driven by higher interest rate margins. The average impact on the annual GDP growth is around 0.03 per cent.<sup>71</sup> Slovik and Cournède (2011) and EU (2011) find similar results. IIF (2011) finds significantly larger impacts,<sup>72</sup> arguing that the return on equity must be maintained and increased, which will increase the lending spread by significantly more than estimated in the other studies.

Several studies look at the interaction between monetary policy and higher capital requirements in a DSGE framework, considering the business cycle. The findings

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<sup>71</sup> MAG (2010b) finds that bringing the global common equity capital ratio to a level that would meet the agreed minimum and the capital conservation buffer would result in a maximum decline of 0.22 per cent of GDP after 35 quarters. The spillover effects across countries are estimated at 0.17 per cent of GDP.

<sup>72</sup> Their estimate shows that the introduction of the Basel III requirements could total 3.2 per cent of GDP for the developed economies, which implies 7.5 million jobs forgone.

indicate that better coordination, particularly during financial shocks, tends to reduce economic costs (Angelini, Neri, and Panetta 2011; Angeloni and Faia 2009; Bean et al. 2010).

Burgess *et al.* (2016) estimate the impacts of higher capital requirements for the United Kingdom in a stock and flow consistent model. They study the impacts of an increase in the required risk-weighted capital ratio achieved through raising equity capital. The results indicate a small impact. The lending rate increases by 15 basis points and the level of GDP declines by 10 basis points.

The outcomes in the different studies are highly dependent on the assumptions being made. For example, Zhu (2008) argues that many banks hold capital above the requirements and thus the impacts should be small. Banks with a higher than the required capital ratio may be perceived as better managed and safer, and likely to see a decline in funding costs (Noss and Toffano 2016). It is also important how the new capital requirement is achieved (Cohen and Scatigna 2016; Zhu 2008). For example, achieving the new ratio through reducing dividends is unlikely to have the same impact on the credit cycle as reducing the loan portfolio. Banks can also issue equity or substitute riskier assets with safer ones, and they can also restructure their business models, reducing inefficiencies and compensation costs (Allen *et al.* 2012; MAG 2010a).<sup>73</sup>

De Marco and Wieladek (2015) identify three conditions that need to be satisfied for higher capital requirements to affect loan supply: the cost of bank equity must exceed the cost of debt; capital requirements must be binding on a bank's choice of capital; and the sources of funding of borrowers must be limited.

Cohen and Scatigna (2016) provide empirical evidence on how banks in advanced and emerging economies have achieved their capital requirements. Looking at data from 2009 to 2012, they find most banks have achieved their capital requirements through an increase in retained earnings rather than a reduction in loans. The impact on lending spreads is small. However, they also find some differences across countries. For some banks in advanced economies, a reduction in risk-weighted assets has helped with the adjustment to higher capital ratios. For European Banks,

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<sup>73</sup> Cohen and Scatigna (2016) explain how the different options are operationalised, and the advantages associated with each.

some of this adjustment has taken place by reducing cross-border assets. There is also some evidence that banks with lower capital ratios at the beginning of the period were more likely to see an adjustment through a reduction in asset growth. This supports the argument put forward by Zhu (2008).

Recent empirical studies, looking at UK data, find that the higher capital requirements have reduced lending domestically as well as cross-border lending (Aiyar *et al.* 2014; Bridges *et al.* 2014; Noss and Toffano 2016). The impact of a 1 percentage point increase in the capital requirement on loan volumes is a reduction in the region of 3.5 to 8 per cent. This effect is not the same across firms. Firms with multiple bankers or alternative sources of funding or those that borrow from banks with better capital ratios are less affected by the higher capital requirements (Bridges *et al.* 2014; De Marco and Wieladek 2015).

A fundamental problem with the macroeconomic impact studies is their inability to capture the channels identified by Borio and Zhu (2012) and Woodford (2010). Some of the estimates rely on econometric and DSGE models that have no financial sector dynamics. The impact on interest rate spreads is estimated outside the model and then the system is shocked accordingly. The most advanced tools used to estimate the likely impacts are DSGE models. These models assume rational expectations and dynamics based on a representative agent, implying almost perfect foresight of risk, and thus it is harder to incorporate cross-sectional and inter-temporal coordination failures (Borio and Zhu 2012). The models are often linear and thus have no nonlinear dynamics and liquidity, which amplify the risk-taking channel. This makes it difficult to operationalise the risk-taking channel.

The criticism of linear dynamics is addressed by either introducing the financial accelerator mechanism as defined by Bernanke, Gertler, and Gilchrist (1999) or the household collateral constraint mechanism following the approach by Iacoviello (2005). Borio and Zhu (2012), however, argue that the financial accelerator mechanism is not able to capture the dynamics of risk-taking as it ignores the time varying pricing of risk and effective risk tolerance. The financial accelerator mechanism works through the balance sheet of a representative firm, but it ignores how other balance sheets are affected and all balance sheets interact to determine

the impact on the economy. The same criticism applies to the model developed by Iacoviello (2005).

The absence of stock and flow consistency in DSGE models prevents them from capturing the distribution of risk in the economy, which is important for understanding the risk-taking channel and in capturing the interlinkages between the balance sheets of various agents in the economy. These interlinkages can generate significant multiplier effects as idiosyncratic risks become systemic.

While the stock and flow model developed by Burgess *et al.* (2016) provides a richer representation of the financial sector, it also lacks a financial accelerator mechanism, which represents the dynamics identified by Borio and Zhu (2012).

Recent studies looking at the impact of higher capital requirements on the South African economy also lack balance sheet dynamics. Havemann (2014) and Grobler and Smit (2014) modify large macroeconometric models (without microeconomic foundations) to include an interest rate spread which is driven by a number of factors including the capital adequacy ratio. Their results indicate a small impact on the economy from 1 per cent increase in the capital adequacy ratio, primarily driven by the increase in the interest rate spread.

Our analysis aims to build on previous studies by studying the impact of higher leverage ratios in a model which explicitly models balance sheet dynamics of all economic agents in a stock and flow consistent way. We consider the multiplier effects which characterise the financial sector.

### 6.3 Model Changes

This section outlines changes to the base model in order to make it suitable to study the impact of higher leverage ratios on the economy.

We introduce the equation:

$$CRR_t = \frac{(sl^{fin,e} + SSAVFIN_t)}{FWCRR_t}$$

where  $CRR_t$  is the required leverage ratio, which is exogenously determined.  $sl^{fin,e}$  is the equity capital of the financial sector calculated at book value excluding retained earnings.  $SSAVFIN_t$  is the value of retained earnings (the stock of savings)

and  $FWCRR_t$  is the value of assets at book value. The use of book values rather than market values simplifies the model solution. The impact of market value dynamics on the overall results depends on the composition of assets and consequently on how changes in market prices affect the numerator of the leverage ratio vis-à-vis the denominator. This is an item for further research.

$sl^{fin,e}$  is fixed in the base model set out in Chapter 3. In the present version of the model, it can vary in some of the simulations, illustrating how raising equity capital to achieve the higher leverage ratio may affect the economy.

In the base model the financial and non-financial sector savings adjust to ensure that total investment is equal to total savings. The model used in this chapter assumes that financial sector savings are a function of its after-tax income and interest, dividend, social contributions and other expenditure. Here the dividends paid by the financial sector are a fixed share of after-tax income calibrated to the average value over the period 2002 to 2012. Changes in this share represent the dividend policy of the financial sector and have a direct impact on retained earnings. The non-financial sector savings are a fixed share of its after-tax income. The foreign sector savings are not fixed as in the base model but adjust to ensure that the savings-investment balance is maintained. The external balance closure remains an adjustment through the exchange rate.

There are number of changes that we make to the adjustment mechanism in the loan market. These are required as we assume that the loan liabilities of the financial sector are the adjustment mechanism in response to a contraction in the financial sector balance sheet. We outline the changes below:

- Demand for loans from the financial sector no longer depends on borrowing costs in the economy. The reduction in the value of assets requires an adjustment on the liability side. The adjustment takes place through cash and deposits, with loans (liability) being the balancing item.
- The lending rate does not ensure equilibrium in the lending market. The loan rate is a function of the repo rate and a lending spread which fluctuates with the growth of the financial wealth of the financial sector. Deviations which exceed the steady state growth rate reduce the spread, whereas growth rates

below the steady state rate increase the lending spread. The steady state is calculated as the average over the period 2002 to 2012.

- The supply of loans by the non-financial sector adjusts to ensure equilibrium in the loan market.

## 6.4 Results

There are different ways for banks to achieve the higher capital requirements as highlighted in the literature. The simulations aim to illustrate how these different approaches are transmitted in our framework and how they affect the economy.

In the first simulation, we model the impact on the economy by assuming that banks cannot raise more equity and have to reduce the total value of their assets, while at the same time cutting the loans (debt) on the liability side. In the second simulation, we illustrate how increasing retained earnings can reduce the initial negative effects. This, however, also leads to lower household consumption in the short run. The results from the two simulations are compared against two scenarios, which assume that banks can raise equity and thus they do not have to shrink their balance sheet. We illustrate the impact if it is costly to raise equity against a scenario where the higher equity issuance does not translate into higher loan spreads.

### *Reducing the value of bank assets to achieve the higher capital ratio*

The required leverage ratio for South Africa is 4 per cent, higher than the Basel requirement of 3 per cent. The shock to the system is assumed to be a 25 basis points regulatory increase to the required leverage ratio, which is introduced gradually over a period of four quarters. In simulation 1, the loans on the liability side adjust to match the decline in the value of assets. In simulation 2, the loans adjust and the financial sector dividend payments are cut by ten per cent.

The general response of **the financial sector** is driven by the *capital threshold effect as identified* by Borio and Zhu (2012). The financial sector responds to the new requirements because it is costly if it does not. In order to achieve the higher leverage ratio, the financial sector reduces the value of all its assets, except the holding of bonds (Table 6.1). This effect is driven by the Tobin asset demand function. The relative increase of bond returns to other assets leads to an increase

in the financial sector holdings of bonds. This increase is required to ensure that the issued bonds are absorbed by the market.

This mechanism links the bond rate to the contraction in the balance sheet of the financial sector. Higher capital requirements are likely to affect the demand for bonds and reduce the sustainability of fiscal policy in the short-run. The increase in the bond rate in Figure 6.2 (panel 4), far exceeds the increase in the loan rate. Burgess *et al.* (2016) find that the bond rates decline, but in their simulation the transition is done through increasing the equity capital of the financial sector

**Table 6.1: Changes to the holding of financial assets**

	Assets							
deviation from baseline	Equities		Bonds		Cash and dep		Loans	
t+10	sim1	sim2	sim1	sim2	sim1	sim2	sim1	sim2
Reserve Bank	-0,3	-0,1	-0,1	-0,4	0,0	0,0	0,0	0,0
Financial sector	-1,8	0,0	1,8	2,1	-2,1	-0,1	-1,4	-0,5
Non-financial sector	-0,3	-0,1	0,0	0,0	-0,2	-0,2	-1,3	0,9
Households	-0,9	-0,7	0,0	0,0	-0,4	-0,3	0,0	0,0
Government	-0,3	-0,1	0,0	0,0	-0,3	-0,3	-0,2	-0,2
ROW	-2,8	-2,7	1,3	-0,5	-5,5	-4,0	-2,3	-2,5

Source: Model simulations

**Table 6.2: Changes to the holding of financial liabilities**

	Liabilities							
deviation from baseline	Equities		Bonds		Cash and dep		Loans	
t+10	sim1	sim2	sim1	sim2	sim1	sim2	sim1	sim2
Reserve Bank	-0,3	-0,1	0,0	0,0	-0,3	-0,3	0,4	0,2
Financial sector	-0,7	-0,5	0,0	0,0	-1,4	-0,4	-2,6	-0,1
Non-financial sector	-3,3	-1,6	0,0	0,0	0,0	0,0	-0,4	-0,1
Households	0,0	0,0	0,0	0,0	0,0	0,0	-0,5	-0,2
Government	-0,3	-0,1	1,5	1,2	0,0	0,0	-0,5	-0,1
ROW	-0,6	-0,4	0,1	0,3	0,1	0,3	-0,4	-0,2

Source: Model simulations

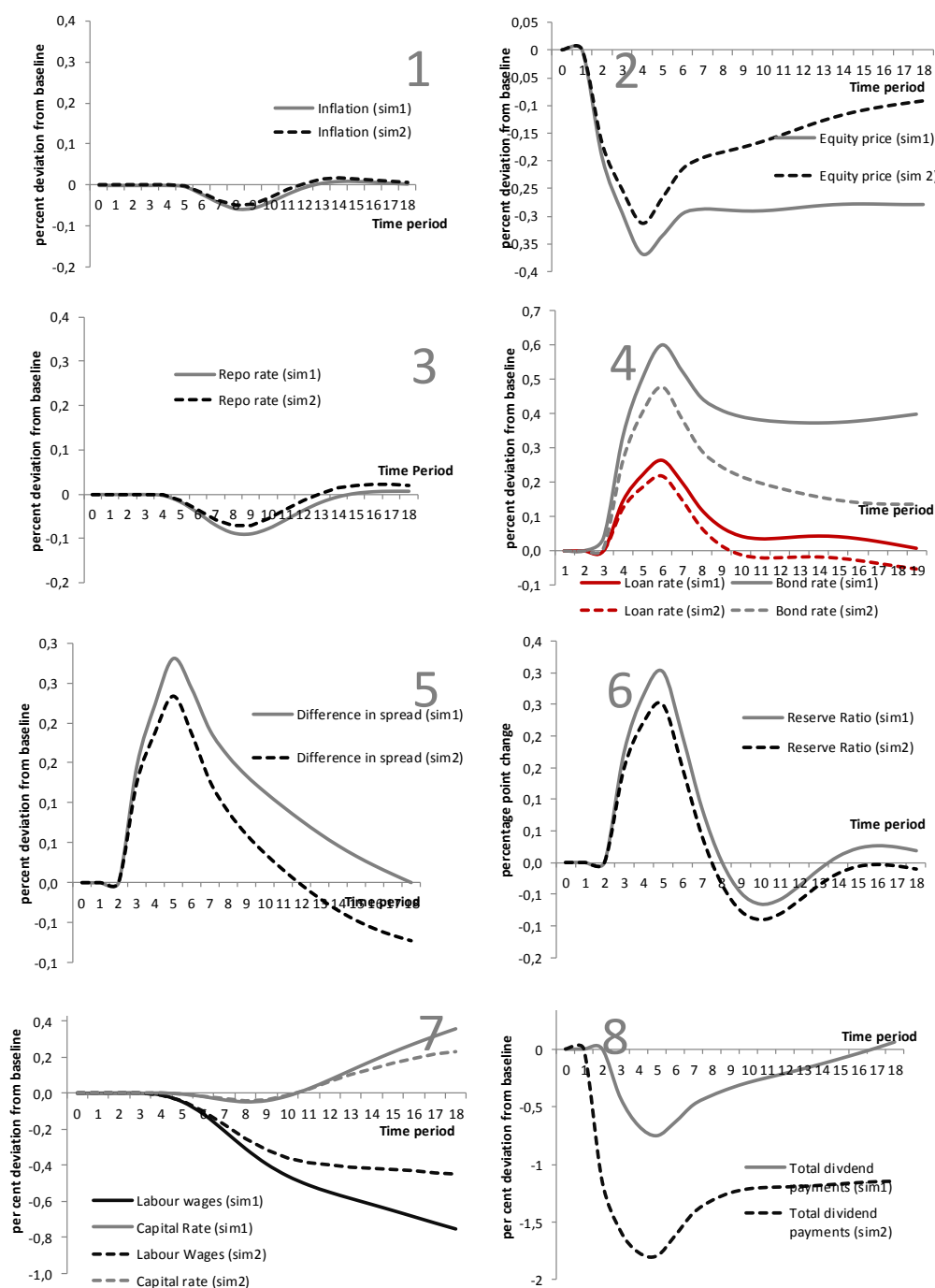
The loans on the asset side decline for two reasons. Firstly, the deposits into the financial system decline across institutions as illustrated in Table 6.1 due to the slower pace of economic activity. The decline in the cash and deposit assets of the financial sector amplifies this effect.

Secondly, the willingness of the financial sector to hold reserves increases, as illustrated in Figure 6.2, which decreases the money multiplier and the supply of loans. The reduction is driven by the fall in the value of financial assets, which in our framework translates into greater willingness by the financial sector to hold cash reserves. This increase in the willingness to hold reserves reflects higher risk



perceptions of the economic environment. The impact on the reserve ratio aims to operationalise the *capital framework effect* in our model (see Borio and Zhu (2012)).

**Figure 6.2: Impacts on rates and prices**



Source: Model simulations

The combination of lower deposits and higher reserves translates into lower levels of intermediation. The bank decreases the growth rate of its assets relative to the baseline. The fall in the value of bank assets translates into a reduction in the supply of loans relative to the baseline and an increase in the lending spread by 0.3 percentage points (Figure 6.2, panel 5). This mechanism captures the model presented by Woodford (2010). Changes to the financial sector capital and perceptions of risk change the supply of intermediary services, impact the balance sheet of the financial sector, which affects the interest rate spread.

The lower level of intermediation reduces the growth in money supply and affects the equity price through equation 17. The initial fall is 0.35 per cent decline compared to the baseline. This affects the balance sheet of all institutions, particularly households.

In Table 6.2 above, the fall in the financial assets of the financial sector is matched by a decline in all liabilities except bonds. We assume that the financial sector does not issue bonds. The adjustment item is the loan debt, which declines by 2.6 per cent relative to the baseline. The decline in equities is driven by both prices and quantity effects. The latter reflects a decline in the equity assets of households which are equity liabilities of the financial sector according to our model specification.

The investment by the **non-financial sector**, which is the bulk of investment in the economy, declines (Table 6.3). The decline in investment reflects the higher borrowing costs driven by the increase in the loan rate. For non-financial firms, the fall in investment also reflects the decline in equity prices which feed into the Tobin Q specification. The initial decline is small, but it becomes significant as the equity prices are on a lower growth trajectory. By the 10<sup>th</sup> period investment is just over one percentage point lower in the first simulation compared to the baseline.

The non-financial sector experiences a fall in the value of its assets and liabilities. The largest impact is on the equity liabilities. This impact reflects lower demand for equities as an asset across institutions as well as the lower equity price. The supply of equities by the non-financial sector is residual supply which aims to ensure equilibrium in the equity market.

The **household**, which has limited ability to foresee the future, experiences a fall in consumption. Similar to the fiscal and capital flow reversal shocks, the result is driven by the fall in equity prices and income as well as a fall in the flow of loans as a funding source relative to the baseline. The fall in the equity price reduces the value of current assets and makes it more difficult to achieve the target level of wealth.

**Table 6.3: Impacts on real expenditure**

	only loans		loans plus retained earnings	
per cent deviation from baseline	t+1	t+10	t+1	t+10
Household expenditure	-0,04	-0,13	-0,11	-0,17
Investment				
Non-financial firms	-0,16	-1,13	-0,67	-0,71
Other-institutions	-0,13	-1,18	-0,11	-0,72
Exports	0,03	-0,07	0,07	0,00
Imports	-0,12	-0,33	-0,21	-0,35
GDP	0,00	-0,12	0,01	-0,07

Source: Model simulations

Figure 6.3 shows the household optimisation behaviour. The graph presents the household optimisation behaviour at three points in time: the time the shock takes place ( $t$ ), ten periods after the shock ( $t+10$ ) and 15 periods ( $t+15$ ) after the shock. It plots the difference in growth rates between the baseline and the two simulations.

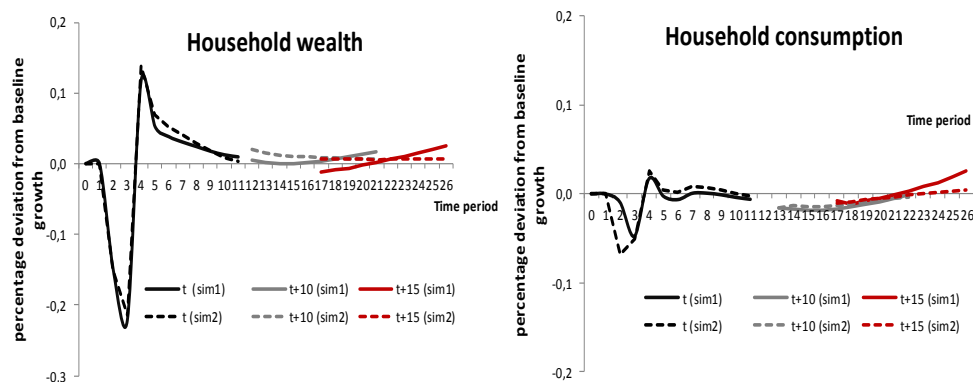
In order to achieve its level of targeted real wealth, household savings need to rise and consumption must fall. This is reflected in Figure 6.3. The growth in household wealth falls initially and then it recovers relative to the baseline. In the right panel, the growth in household consumption follows a similar trend in the first optimisation period (the black line). Stronger growth in household wealth is required in the second half of the first optimisation period in order to achieve the target level of wealth. This is supported by higher levels of domestic savings and the lower levels of inflation, which make it easier to achieve the target level of real wealth. The household also has expectations that economic conditions will

normalise based on their model consistent expectations, which allow them to accelerate consumption in the outer years of the first optimisation period.

Looking at period  $t+10$ , the growth in household wealth is close to the baseline, whereas the household consumption growth rate is marginally below the baseline. The household expectation of recovery has not materialised. Consumption growth rates have to be lower in order for the real wealth target to be achieved. While households foresee some improvement in economic conditions in period  $t$ , they cannot foresee the subsequent shocks in the next optimisation periods  $t+1$ . It is only by period  $t+15$  that baseline and simulation growth rates are equal.

In Table 6.1 above, household's stock of equities falls due to the lower equity price and lower income relative to the baseline. On the liability side, the stock of loans declines by 0.5 per cent as lending rates increase and household income falls relative to the baseline.

**Figure 6.3: Household consumption optimisation behaviour**



Source: Model simulations

**Government** consumption expenditure remains unchanged relative to the baseline as it is exogenously determined. On the financial side, government sees a decline in its stock of loans as a source of funding. This reflects lower income and higher real rates. The bond issuance increases in line with the slower pace of tax revenue collection and dividend income. This is a major driver behind the higher bond rates. Given the contraction in the balance sheet of the financial sector, higher supply of bonds requires even higher bond yields. We model exogenously the volume of equities for the government sector and thus the declines on the asset and liability sides reflect the fall in the equity price relative to the baseline.

In line with the lower income and higher debt levels, the government reduces its extension of loans and demand for cash and deposits. This reinforces the multiplier effect described above, as it contributes to lower deposits with the financial sector. We assume that the level of government debt remains sustainable. In the presence of unsustainable levels of debt, government consumption would have to respond amplifying the real economy impacts.

For the **Reserve Bank**, its debt liabilities increase marginally (Table 6.2). The Reserve Bank's income increases marginally due to the higher interest rates, which drive interest income. Most of the income of the Reserve Bank is interest income. The higher levels of income lead to a higher demand for loans.<sup>74</sup> The growth in money supply represented by the extension of cash and deposits declines as overall income in the economy falls. For equities, the decline is driven by the fall in the equity price as the quantity of shares is assumed exogenous. On the asset side, the decline in the sources of funding relative to the baseline translates into lower demand for government bonds, which puts further pressure on the bond rate in order to encourage demand by the financial and foreign sectors.

The impact on the **foreign sector** is driven by the fall in foreign savings and the depreciation of the currency. The two effects move in opposite directions. The fall in foreign savings reduces the levels of financial wealth, whereas the depreciation increases the value of the foreign sector liabilities and thus the sources of funding. The equity and loan liability decline as they are a function of the nominal level of domestic GDP expressed in foreign currency units. This mechanism links stronger domestic growth and currency with greater purchases of financial assets by domestic residents from the rest of the world.

The value of bonds and cash and deposit liabilities is kept constant in foreign currency units and thus the increase in the value reflects the weaker currency.

The provision of loans by the foreign sector is a function of its total financial wealth and the repo rate. A lower repo rate encourages lending as economic conditions are likely to improve. However, in this case the decline in financial wealth dominates the impact, and the stock of loans provided by the foreign sector declines relative

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<sup>74</sup> The loan demand is function of real interest rates and nominal income.

to the baseline. The demand for other assets is modelled as a Tobin asset demand function. The fall in financial wealth available for investment decreases the stock of equities and cash and deposits held by the foreign sector. The decline in cash and deposits contributes to the decline in lending by the financial sector. The stock of bonds increases, driven by the jump in the bond rate. This exacerbates the retreat from equities and cash and deposits.

The depreciation of the currency, driven by the fall in foreign savings causes net exports to rise. The relatively low responsiveness of exports to the exchange depreciation is in line with recent South African experience. These responses are dependent on the elasticities of substitution in the Constant Elasticity of Transformation and Armington functions.

Table 6.4 presents the impacts on net financial wealth, which is measured as the difference in value between the value of assets and liabilities divided by nominal GDP. It is assumed that the impact on the net wealth of the Reserve Bank is always neutral. For the financial sector, the initial impact is also neutral as the adjustment to the higher capital ratio reflects only changes in the balance sheet of the sector. However, as real economy effects start to feed in, the financial sector sees a marginal improvement in its net wealth. The improvement in the non-financial sector net wealth is driven by the fall in equities issued by the sector as well as the fall in the equity price. The non-financial sector provides equities on demand. For all other institutions, the net financial wealth declines in the first simulation relative to the baseline. This decline is more pronounced ten periods after the shocks.

**Table 6.4: Net financial wealth**

Net Financial Wealth change as percent of GDP	only loans		loans plus retained	
	t+1	t+10	t+1	t+10
Reserve Bank	0,0	0,0	0,0	0,0
Financial sector	0,0	0,6	0,2	1,6
Non-financial sector	0,5	2,9	0,5	2,0
Households	-0,2	-0,4	-0,2	-0,4
Government	0,0	-1,2	0,0	-1,0
ROW	-0,3	-1,9	-0,4	-2,3

Source: Model simulations

The results reflect the operations of our accelerator mechanism. The negative impact on balance sheets, the lending spread and equity prices translate into real effects, which reinforce the financial effects. The continuous interaction between the real and financial sides of the economy and the interaction between institutions in the various markets lead to an amplifying mechanism.

We now move to our second simulation. The empirical literature indicates that most of the adjustment to higher capital ratio has taken place through a reduction in dividends. We illustrate how an increase in retained earnings affect our results. We assume that the financial sector reduces the dividend payouts by ten per cent relative to the baseline. This is a permanent decline over the entire period. The results are labelled as *sim2*. The lower dividend payments increase the retained earnings of the financial sector and reduce the need for a reduction in the value of assets held by the financial sector. The contraction in the balance sheet of the financial sector is significantly smaller. In Table 6.1, the financial sector equity holding remains unchanged, the value of bond holdings increases by more compared to the first simulation, while the holding of cash and deposits and the supply of loans experience smaller contractions relative to simulation one. By period  $t+10$ , the loans as a source of funding in Table 6.2 decline by 0.1 per cent compared to 2.6 per cent in the first simulation.

This lower contraction in the balance sheet of the financial sector translates into lower economic impacts. The negative impacts on the lending spread, equity prices and the reserve ratio are significantly smaller as shown in Figure 6.2. Other balance sheets in the economy also experience smaller contractions compared to the first simulation (Table 6.1 and Table 6.2). The negative impacts on the economy are smaller, as the decline in investment relative to simulation one is significantly smaller.

One exception is the impact on household consumption. Household income is highly dependent on dividend income. The fall in dividend pay-outs, shown in Figure 6.2, leads to a fall in household income, which makes it more difficult for the representative household to achieve its real wealth target. They need to save more as a share of their income in the short run, which translates into lower consumption. This channel highlights the importance of flow consistency and the

strength of our framework. While higher retained earnings reduce the negative impacts on the financial sector, they increase the adverse effects on institutions, which receive a high share of financial sector dividend payments.

The optimisation behaviour shown in Figure 6.3 shows the sudden drop in household consumption in the second simulation. The drop is larger than in the first simulation. The growth rate recovers in the outer periods, however the level remains below the baseline and the first simulation.

In terms of impacts on net wealth, only households and the rest of the world see no improvement in their positions. In the case of households, this is driven by the drop of income. In the case of the foreign sector, the decline is driven by a larger depreciation of the currency due to lower reliance on foreign savings compared to simulation one.

#### *Achieving the higher ratio through higher equity capital*

We provide additional two simulations which show the impact on the economy if the higher capital ratio is achieved by higher issuance of equity. In the first simulation, we assume that the conditions identified by De Marco and Wieladek (2015) are not satisfied. Banks can raise equity and there is no significant cost to it. In the second simulation, we introduce cost by exogenously shocking the spread (raising equity is expensive and the bank passes the cost onto its customers). The second simulation is similar to the simulations in most of the models used to study the impact on capital requirements, where the spread is shocked exogenously to account for the cost of equity.

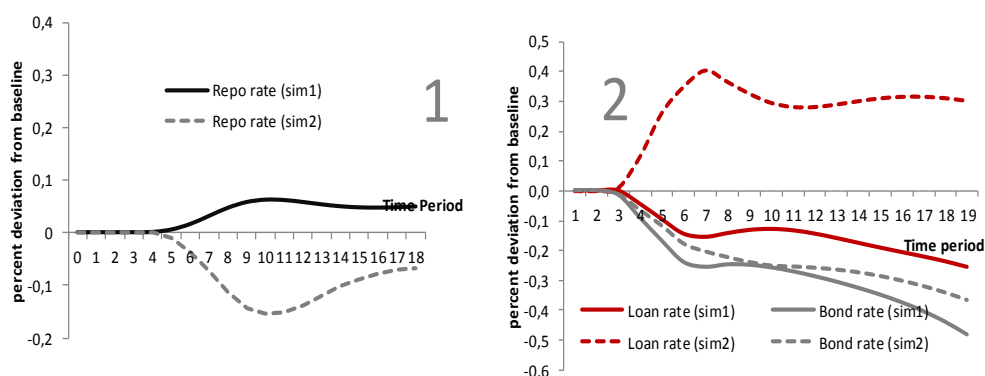
In Figure 6.4, we show the impact on the repo rate and bond and loan rates. Here *sim1* refers to the first simulation with no impact on the spread and *sim2* to the second simulation with a higher lending spread. The shock is implemented by releasing the equity constraint on the financial sector. Unlike the previous two simulations where we assumed that banks cannot raise equity, now we assume that the constraint is no longer in place.

Instead of shrinking the value of their assets, banks can increase their capital. In *sim1*, banks experience a capital injection through an increase in equity capital, which is not accompanied by higher spreads. Table 6.6 shows the large increase in the equity debt of the financial sector. While this leads to a rise in the leverage



ratio, it also increases the value of liabilities and it requires a corresponding increase in the value of assets (we assume that an increase in the equity capital is not accompanied by a decline in other liabilities). This increase in the value of the financial sector assets is expansionary. The increase in the equity liability of the financial sector increases the sources of funding and it allows for an increase in the financial wealth of the sector.

**Figure 6.4: The impact on interest rates following issuance of capital**



Source: Model simulations

The increase in financial wealth available for investment leads to higher demand for cash and deposit, equities and bonds. The stronger growth in the value of assets compared to the baseline reduces the reserve ratio as the financial sector perceptions of risk are reduced. This increases lending and reduces the loan spread as shown in the second panel of Figure 6.4. This is despite an increase in the repo rate driven by the better economic conditions and higher inflation. The higher demand for bonds reduces the bond rate as shown in the second panel of Figure 6.4.

The reduction in the lending spread driven by the stronger growth in the balance sheet of the financial sector leads to a lower real borrowing rate and higher investment relative to the baseline (Table 6.5). Equity prices benefit from an increase in money supply as the financial sector deposit creation accelerates, but also from higher levels of economic activity. The combination of cheaper loans and higher equity prices makes it easier for the household to achieve its level of target wealth, and thus it can increase its level of consumption (Table 6.5).

The sources of funding for the foreign sector are negatively affected by an exchange rate appreciation. This is reflected in the marginal decline of the bond and cash and deposit liabilities for the sector. However, the higher domestic economic activity

encourages the purchases of foreign assets by domestic residents, which increases the equity and loan liability of the foreign sector. The sector decreases its holding of bonds as the relative return of bonds declines.

**Table 6.5: Real economy impacts of raising capital through equity issuance**

	equity		equity plus spread	
per cent deviation from baseline	t+1	t+10	t+1	t+10
Household expenditure	0,05	0,27	-0,39	-0,47
Investment				
Non-financial firms	0,05	1,22	-1,29	-1,88
Other-institutions	0,04	1,25	-0,11	-2,85
Exports	-0,03	-0,03	0,22	-0,01
Imports	0,09	0,63	-0,68	-1,15
GDP	-0,01	0,08	0,04	-0,21

Source: Model simulations

The impact on the non-financial sector serves as a constraint to the positive impact from the initial shock. The injection of equity in the financial sector reduces the equity purchases from the non-financial sector as shown in Table 6.6. Investors may believe that the banks are well run with good profit projections, and they take advantage of the opportunity to purchase new equity capital. This causes the financial wealth of the non-financial sector to fall and it translates into a reduction in the loans extended by the sector. The fall in the sources of funding requires a decline in the uses of funding. The reduction of loans extended by the non-financial sector provides a marginal offset against the higher supply by the financial sector. A stronger demand for equities by the financial sector and other institutions can reduce the negative impact of this channel and amplify further the accelerator mechanism in the model framework. Equity demand must be more elastic to changes in the return.

The overall impact on GDP in Table 6.5 is marginally positive as stronger import growth offsets somewhat the positive effects from higher domestic aggregate demand. These effects are only likely if the banks are already well capitalised and managed, and there is high demand for their equities.

In the next simulation, the higher equity flows are accompanied by an exogenous increase in the loan spread equivalent to 50 basis points. This is reflected in the higher loan rate in Figure 6.4. The real economic effects are significantly worse compared to the first simulation as the higher loan rate discourages demand for loans by institutions, which affects negatively consumption and investment (Table 6.5). The extension of loans in Table 6.6 declines across institutions, except for the financial sector.

**Table 6.6: Changes to the holding of financial assets when equities are unconstrained**

	Assets							
deviation from baseline	Equities		Bonds		Cash and dep		Loans	
t+10	sim1	sim2	sim1	sim2	sim1	sim2	sim1	sim2
Central Bank	0,4	0,0	0,0	-1,5	0,0	0,0	0,0	0,0
Financial sector	4,6	3,6	0,3	0,8	4,7	3,9	2,5	2,0
Non-financial sector	0,4	0,0	0,0	0,0	0,0	-0,6	-2,4	-4,6
Households	0,3	0,3	0,0	0,0	0,3	-0,8	0,0	0,0
Government	0,4	0,0	0,0	0,0	0,3	-0,6	0,1	-0,2
ROW	0,8	-2,9	-4,5	-6,3	2,1	-1,5	0,2	-2,9

Source: Model simulations

**Table 6.7: Changes to the holding of financial liabilities when equities are unconstrained**

	Liabilities							
deviation from baseline	Equities		Bonds		Cash and dep		Loans	
t+10	sim1	sim2	sim1	sim2	sim1	sim2	sim1	sim2
Central Bank	0,4	0,0	0,0	0,0	0,3	-0,4	-0,8	-0,5
Financial sector	6,6	6,1	0,0	0,0	2,7	1,7	0,0	0,0
Non-financial sector	-1,2	-3,9	0,0	0,0	0,0	0,0	0,9	-2,2
Households	0,0	1,0	0,0	0,0	0,0	0,0	1,1	-2,3
Government	0,4	0,0	-0,6	-0,6	0,0	0,0	1,1	-2,1
ROW	0,6	-0,5	-0,6	1,0	-0,6	1,0	0,2	-0,5

Source: Model simulations

The value of assets held by the **financial sector** increases following the mechanism outlined in the previous simulation, but the increases are smaller (Table 6.6). While the balance sheet of the financial sector does not contract, the cost of borrowing is higher relative to the baseline and *sim1*. This is despite a fall in the repo rate. The higher lending rates have negative effects on economic activity

Investment by **non-financial institutions** declines, initially due to the higher lending rates and in the outer simulation periods due to lower equity prices and

economic activity. The lower levels of economic activity along with the capital raising of the financial sector affects negatively the sale of non-financial sector equities. Like the previous simulation, the decline in the sources of funding is matched by a decline in the extension of loans. The reduction in loans is larger than in the first simulation and offsets the stronger provision of loans by the financial sector.

**Household** consumption also declines relative to the baseline and *sim1*. Lending to the representative household decreases as the lending rate is higher. Equity prices also decline relative to the baseline as the level of economic activity decelerates. The combination of a decrease in the sources of funding and lower equity prices requires that the household saves more to achieve the same level of target wealth. This leads to a decline in household consumption.

The **Reserve Bank** sees an increase in its interest income relative to the previous simulation, which is still lower than in the baseline. This leads to a marginally smaller decline in loan liabilities. However, the lower overall income in the economy decreases the growth of cash and deposits liabilities for the Reserve Bank. This is matched by a decline in the holding of bonds.

The rand depreciates, which cushions the impact on the sources of funding for the **foreign sector**: the value of bonds and cash and deposits increases. However, equities and loans decline as domestic GDP expressed in foreign currency units is lower and the inflows of foreign savings fall relative to the baseline. Overall, the financial wealth of the foreign sector declines, and the net wealth of the domestic economy vis-à-vis the foreign sector improves.

The depreciation of the currency also improves net exports, which reduce the overall negative effects on GDP.

The increase in the loan spread reduces the positive effects associated with the expansion of the balance sheet of the financial sector. In our framework, a small increase of 50 basis points is sufficient to offset the positive effects from the first simulation. The mechanism works through the reduction in the demand for loans and the impact on household consumption and investment. This in turn affects the demand for financial assets by institutions, which offsets the positive effects associated with the expansion of the financial sector balance sheet. The real and

financial elements of our framework interact to determine the net effect on the economy.

The results also highlight how macroprudential policies may affect the transmission and effectiveness of monetary policy decisions. The introduction of higher leverage ratio requirements affects the lending spread, depending on how the higher ratio is achieved. In our framework, the monetary policy response is not sufficient to offset the impact of the higher lending spread on borrowing costs.

There are three key challenges for monetary authorities. They need to understand how the financial sector will respond to the higher leverage ratio (the capital threshold effect) and how their risk behaviour will change (the capital framework effect) and then assess the likely impact on the lending spread. The change in macroprudential regulation affects the risk-taking channel identified by Borio and Zhu (2012) and thus the operations of monetary policy. In setting policy rates or introducing other monetary policy interventions, central bankers must consider these effects. Otherwise borrowing rates may be either too high or too low compared to the policy desired level, as the lending spread shifts, and this can lead to unintended impacts on economic activity.

Current mainstream models, however, do not capture these channels and thus provide limited assistance to central bankers in setting policy rates optimally. Our framework builds on current models and it introduces some novelties. The first one is the stock and flow consistency, which shows the stock and flow adjustments across institutions. Changes in financial assets and liabilities can be due to quantity but also price changes, particularly equity prices. The presence of stock and flow dynamics implies that shocks to the capital ratio will have a very different impact depending on the starting point. A movement in the ratio from 5 to 6 per cent requires a significantly larger adjustment than a movement from 13 to 14 per cent even though the absolute increase is the same. Econometric models tend to internalise the direct impact of financial ratios on the lending spread, but do not model the actual stock changes that drive them. This assumes that the relative changes do not have a material impact if they lead to the same absolute change.

The second novelty is the mechanism, which drives the movements in the willingness to hold reserves by the financial sector. This proxies risk taking and affects loan extension, money creation and the lending spread.

The third one is the presence of model-consistent expectations within period, which can change between periods. This allows us to introduce changes in risk perceptions and address some of the criticisms raised by Borio and Zhu (2012) against rational expectations models.

The accelerator mechanism in our framework operates through the balance sheets of all institutions, the desire of the financial sector to hold reserves as a management strategy against risk and the interaction between the real and financial elements of our model economy.

These properties also make the model significantly different from the models used by Grobler and Smit (2014) and Havemann (2014) as well as the models used in international studies such as MAG (2010b) and Slovik and Cournède (2011). The closest model to our framework used to evaluate the impact of higher capital requirements is the one developed by Burgess *et al.* (2016). These authors look at the economic impact of the risk-weighted capital ratio. While their framework is also stock and flow consistent, behaviour in the two models is significantly different. Amongst other differences, their framework does not have the same mechanism for banks to change their reserves in response to higher perceptions of risks, and households are not optimising intertemporally.<sup>75</sup>

The results generated by Grobler and Smit (2014) and Havemann (2014) rely on a econometric equation which links the lending spread directly to the capital adequacy ratio. There are no balance sheet dynamics and the capital ratio is not a function of the financial sector balance sheet. It is modelled exogenously. Havemann (2014) finds that a 100 basis points increase in the capital ratio leads to a decline of 0.07 percentage points in GDP growth. The lending rate increases by 0.4 percentage points. Grobler and Smit (2014) generate a stronger impact on GDP, which declines by 0.2 to 0.3 percentage points relative to the baseline. Our results

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<sup>75</sup> We provide a more comprehensive comparison in the model description chapter.

are of similar magnitude but this is driven by a large adjustment in imports.<sup>76</sup> The impact on domestic demand is a decline by more than 0.5 percentage points relative to the baseline.

## 6.5 Conclusion

Our results confirm that, depending on how the capital requirements are achieved, the impact on the economy can be significantly different with some institutions and some components of GDP being more affected than others. The worst-case scenarios seem to be when adjustment is achieved by a reduction in the value of assets held by the financial sector or when the increase in equity capital translates into a large increase in the lending spread.

Our results also highlight again the importance of stock and flow consistency. Achieving the higher leverage ratio through higher retained earnings seemed less costly for the financial sector. However, this reduces the dividend income of households and has a negative impact on their balance sheet and consumption.

The stock-flow consistency also highlights that if the financial sector increases its equity capital, the equity capital of another sector may fall. This will reduce the sources of funding for that sector and generate negative effects.

Our analysis highlights that by changing the financial sector perceptions of risk through the *capital framework effect*, leverage ratios can affect the transmission of monetary policy decisions. This can cause lending rates to deviate from what a central bank may perceive as optimal levels, and have unintended consequences for the economy. The lending spread can offset policy rate interventions. Policy makers need to understand the impact of macroprudential interventions on risk taking by the financial sector, the impact on lending spreads and extension of loans and the feedback effects through the real and financial behaviour of other institutions. CGFS (2016) indicates that it is uncertain how the introduction of the various

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<sup>76</sup> Our shock is to leverage ratio whereas the shocks by Grobler and Smit (2014) and Havemann (2014) are to the capital adequacy ratio. The shocks are the same in relative terms given the initial value of the respective ratios. Grobler and Smit (2014) and Havemann (2014) do not model risk weights, similar to us. The absence of risk weights in the adjustment assumes that the compositional effects are less important and allows some comparison between the two sets of results.

BASEL III components will jointly affect the transmission mechanism of monetary policy.

Current DSGE models are unable to capture these effects, as pointed out by Borio and Zhu (2012). We have provided an alternative framework that addresses some of the concerns, but not all. More research is required in understanding risk taking and incorporating it in a reasonably realistic way into macroeconomic models.



## Chapter 7 Conclusion

### 7.1 Introduction

In this research, we develop a stock and flow consistent model for South Africa, which draws on the theoretical models developed by Borio and Zhu (2012) and Woodford (2010). Our framework addresses some of the criticisms raised against DSGE models regarding their ability to incorporate financial sector dynamics as well as their specification of expectations. Our approach assumes model-consistent expectations over a finite period of time. The household can change its expectation formation behaviour between solution periods. We argue that our approach resembles bounded rationality, and it is more in line with recent empirical evidence on how individuals form expectations (Hommes 2011; Roos and Luhan 2013).

The model framework is calibrated to South African data and it is used to study: the impact of higher government consumption expenditure on the economy under conditions characterised by significant spare capacity, low government debt and sound financial sector; the impact of capital flow reversal; and the transmission of higher leverage ratio shock.

### 7.2 Main Findings

The main objective of the study was to evaluate the impact of the three macroeconomic shocks and identify the role of the financial sector in the transmission mechanism. We first outline the general findings:

- The financial sector plays an important role in transmitting and amplifying economic shocks. We argue that a stock and flow- consistent framework is required to capture the financial sector dynamics and the distribution of risk. There are strong feedback loops between the real and financial economy and they operate through the balance sheets of all institutions.
- The transmission effects identified by Borio and Zhu (2012) and Woodford (2010) are fundamental to generating the financial accelerator mechanism that characterises the financial sector behaviour.

Chapter 4 presents the capital flow reversal shock results. We argue that the level of financial development plays an important part in the transmission process and

that capital flow reversal shocks can cause discontinuities in economic behaviour. Our main findings are:

- Even in the absence of large stocks of short-term foreign currency denominated debt, the reversal in capital flows can cause a sizable impact on economic activity through its effect on the financial sector. This effect can be particularly large for saving-constrained economies such as South Africa. Demand for domestic assets decreases, which affects negatively equity prices. Liquidity also declines. Financial sector perceptions of risk increase, leading to higher lending spreads. This affects economic activity negatively, leading to further feedback effects.
- The discontinuities, which may characterise capital flow reversal shocks, can significantly exacerbate the impacts. Such discontinuities can emerge if the capital flow reversal shock causes, for example, the bursting of an asset price bubble.

Chapter 5 presents the fiscal shock. We argued that the impact is highly dependent on the economic and financial conditions and the distribution of government debt. The main findings are:

- The fiscal multipliers were larger than 2 in the period 2008 to 2012 as the output gap was large and negative, government debt was low, monetary policy was accommodating and the financial sector was sound. This allowed for the government expenditure shock to be amplified through the financial accelerator mechanism outlined in our framework.
- This effect was strengthened by the large capital inflows, which released the domestic savings constraint.

In Chapter 6, we present the results from the shock to the leverage ratio. We argue that the *capital framework effect* and the *capital threshold effect* identified by Borio and Zhu (2012) are key to the transmission mechanism. Our main findings are:

- The transition to a higher leverage ratio can affect the economy significantly if the banks choose to shrink their balance sheet in order to achieve the higher ratio. Achieving the higher ratio through retained earnings reduces the negative impact on lending spreads but it affects negatively those agents

that rely on dividend income. Our results tend to be more negative than previous studies on South Africa; we argue that this is because of the financial dynamics incorporated in our framework.

- Raising new capital by the financial sector may crowd out the non-financial sector and affect their ability to fund real and financial investment.

### 7.3 Implications

The implications of our research affect future model building and the conduct of macroeconomic policy. In terms of future development of macroeconomic frameworks, the current research illustrates the application and importance of stock and flow dynamics and financial sector behaviour in general. These should be incorporated more widely if current models are to be more relevant to policy analysis. The improvements to the quality of financial data and availability of flow of funds and balance sheet information by the G20 Data Gap Initiative should facilitate the inclusion of financial behaviour into macroeconomic models. We need to guard against creating very complex models, which generate results but provide no insights into the transmission mechanism of shocks. There is a trade-off between being more realistic and having simple models that can inform our understanding of the economy.

In the terms of fiscal policy, our results indicate that the fiscal multipliers can be large, but policy makers must have knowledge of the spare capacity in the economy, the financial sector environment and the feedback effects between fiscal policy and financial sector behaviour. There are strong feedback effects between fiscal policy and the financial sector. BIS (2016) provides a list of the different links. For example, unsustainable fiscal policy weakens banks' balance sheets, tightens credit constraints and it can increase funding costs indirectly as yields increase. At the same time, fiscal policy can reduce the build-up of financial risk by being more contractionary in periods of excessive risk taking. Sovereign and bank credit default swap spreads tend to co-move and influence each other, which also indicates a strong relationship between fiscal and financial sector developments. The relationship is also a function of recent macroprudential regulations, which prescribe the risk profile of government debt and its use in the calculation of capital

and liquidity ratios. These regulations can also change the shape of the yield curve as demand and liquidity for certain debt instruments changes (CGFS 2016).

The large fiscal multipliers were also a function of the monetary policy accommodation as the repo rate remained unchanged. This highlights again the importance of monetary and fiscal policy coordination. However, we argue that this is not sufficient. Monetary policy can have a significant impact on risk-taking by the financial sector and hence affect its behaviour (Borio and Zhu 2012). At the same time, the introduction of BASEL III is likely to change the transmission mechanism of monetary policy and there is uncertainty as to how this will take place (CGFS 2016). Our results on the introduction of higher leverage ratios indicate that monetary policy decisions must consider the higher lending spread, otherwise monetary conditions are likely to be different from those intended by policy makers.

There are feedback loops between fiscal policy, monetary policy, macroprudential policy and the behaviour of the financial sector. This indicates that the old model of monetary and fiscal coordination is outdated. A new model of macro policy coordination is required, which considers these feedback loops.

Finally, our results for the capital flow shock indicate larger contractionary impacts than previously estimated by other studies on South Africa. The effects operate through the financial sector and translate into higher lending spreads. A decline in the repo rate to reduce lending rates and stimulate economic activity may translate into larger outflows and further increases in the lending spread. If the impact on the lending spread is larger than the decline in the repo rate and the real rates rise, economic activity will decline further. This is an area, which requires more academic research to assess the right policy response for economies which have high reliance on foreign savings.

## 7.4 Limitations and Further Extensions

As for any model, our framework is simplified version of reality and is subject to limitations. The first one is our ability to capture heterogeneity amongst agents in the same sector. For example, we have only one household. The implication of this is that we cannot capture all the elements of risk-taking as identified by Borio and Zhu (2012); and our framework, while building on current DSGE and CGE models,

is also subject to some of the same criticisms. The time profile of financial instruments is also missing from our framework. For example, we do not distinguish between short- and long-term bond instruments.

Heterogeneity can be introduced, for example, by distinguishing between credit constraint and non-credit constraint households or by introducing tradable and non-tradable goods in the capital flow reversal shock analysis. However, heterogeneity also introduces complexity and we need to guard against making the model very realistic, but at the same time not useful for economic research as shocks are difficult to trace.

The challenges with data quality and the lack of economic research analysing some of the relationships that we model impose limitations on our results. As indicated before, the flow of funds data and the available balance sheet data for South Africa require some improvements, which are currently being implemented as part of South Africa's commitments to the G20 Data Gap Initiative. This should provide for better quality and availability of data. Improvements to the data will also allow for use of more advanced techniques in calibrating the coefficients, such as the maximum entropy approach.<sup>77</sup> More micro research into understanding bank behaviour and the interactions between the balance sheets of different institutions in South Africa can greatly enhance the robustness of our framework and the results.

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<sup>77</sup> See, for example, Arndt, Robinson, and Tarp (2002). They use the maximum entropy approach to estimate the parameters of a CGE model for Mozambique.

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